# URBAN TRANSPORTATION PROBLEMS IN THE MUSCAT AREA, SULTANATE OF OMAN

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*This Work is Dedicated to*

★★★★★

*My First Educator ⁑ My Father*

☆★☆

*The Memory of My Mother*

☆★☆

*All Members of My Family*

★★★★★

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## ABSTRACT

The economy of Oman, was traditional in character before the development of the oil sector which set in motion the present structural transformation. Economic prosperity gave the opportunity to the public to possess their own private means of transport, thus resulting in a rapid increase in the number of vehicles in the country, particularly in the Muscat Area the capital city of the country. Free essential services such as health and education, and no taxes and duties have led to high disposable household income. Therefore, Muscat is witnessing rapid and successive land-use changes, expansion of the urban area and multi-car owning households.

In the last two decades the population of Muscat increased considerably. This population growth was accompanied by a substantial expansion of Muscat's boundaries to provide homes, work places and other facilities. The topographical nature of the area limited the flat land available for housing, shops, schools, and other elements of the infrastructure. The resulting competition for space had as one of its consequences that insufficient land was allocated for car parking in the major activity centres, and the result was an acute shortage of parking spaces in these areas. The expansion of the Muscat Area was accompanied by changes in the employment and residential pattern. This resulted in a significant increase in number of vehicles, trips and commuting, and so the need for effective transport services and facilities became greater than ever before. The topographical features made it more difficult to provide sufficient transportation facilities. Development planning neglected the importance of arranging urban activities in such a way that the need for vehicle movements would be greatly reduced. It also resulted in low density population areas with street patterns mostly not designed for public transport services.

This study sets out to discuss the problems of urban transportation in the Muscat Area and seeks to answer the following questions: What are the trip characteristics? How far do the natural topographical features inhibit the development of the Muscat road network? How does the existing network serve the needs of the area? How far can it cope with the traffic movement? Will the proposed major roads solve the present problems of traffic congestion and alleviate future ones? What are the main causes for traffic accidents? To what extent are car parking facilities adequate at the major activity centres? What is the role of Oman National Transport Company buses within the public transport system?

The Muscat Area faces problems of traffic congestion and accidents, high demand on parking facilities and inadequate public transport. The situation is liable to deteriorate sharply in the next few years, unless effective action is taken. There is a need for a study that can provide immediate practical solutions and propose guidelines for future policy to ensure that the transport system is expanded and improved to cope with the needs arising from future growth. This study identifies factors contributing to the existing traffic problems with the intention of providing useful information which can help traffic planners and decision makers in understanding the nature of the problems, and finding solutions and guidelines for future policy.

As far as methodology is concerned, a literature review is supported by fieldwork involving questionnaires and contacts with relevant authorities. Four types of surveys were conducted in order to collect information that can identify some of the factors that are contributory to the present problems. On the basis of the analysis of the data collected, urban transport problems are identified and discussed together with some possible solutions and recommendations.

# CHAPTER 1

# INTRODUCTION

## 1.0 - INTRODUCTION

The Sultanate of Oman occupies 300,000 sq. km in the south-eastern corner of the Arabian Peninsula. It borders the Republic of Yemen in the south and Saudi Arabia and the United Arab Emirates in the west. It is composed of varying topographic areas consisting of mountains, fertile plains, valleys and deserts. In some ways Oman has the characteristics of an island, being surrounded by water and sand. The sand is the trackless empty quarter of Arabia, Ruba al-Khali. The water is the Gulf of Oman and the Arabian sea. Ruba al-khali, unlike the ocean, has served as a barrier, (*figure 1.1*).

No comprehensive population census has so far been conducted. However, the population in 1989 was estimated at 2,000,000 for planning purposes according to the Development Council estimates[(1)]. The first commercial oil strike in Oman was in 1964 and exports began in August 1967. Since July 1970 Oman has been undergoing major structural changes. In a short time, a wide range of development programmes were built up from a very rudimentary stage. An unprecedented increase in personal income and rapid expansion of public services have in essence improved the living conditions of the Omanis.

The present study area is confined to the Muscat Area, the capital of the Sultanate of Oman. It has a uniquely complex topographical area of rugged mountains, bays and wide valleys, and a narrow coastal plain interrupted by foothills. The Muscat Area Structure Plan 1989, estimated the total area at 2,300 sq. km. Of this area, approximately 330 sq. km of land is suitable for various kinds of development, while the rest of the total area is dominated by Al-Hajar mountain[(2)].

Because Muscat is the administrative and the economic centre of the country, it naturally has an outstanding position in Oman. The Country's investment capital is

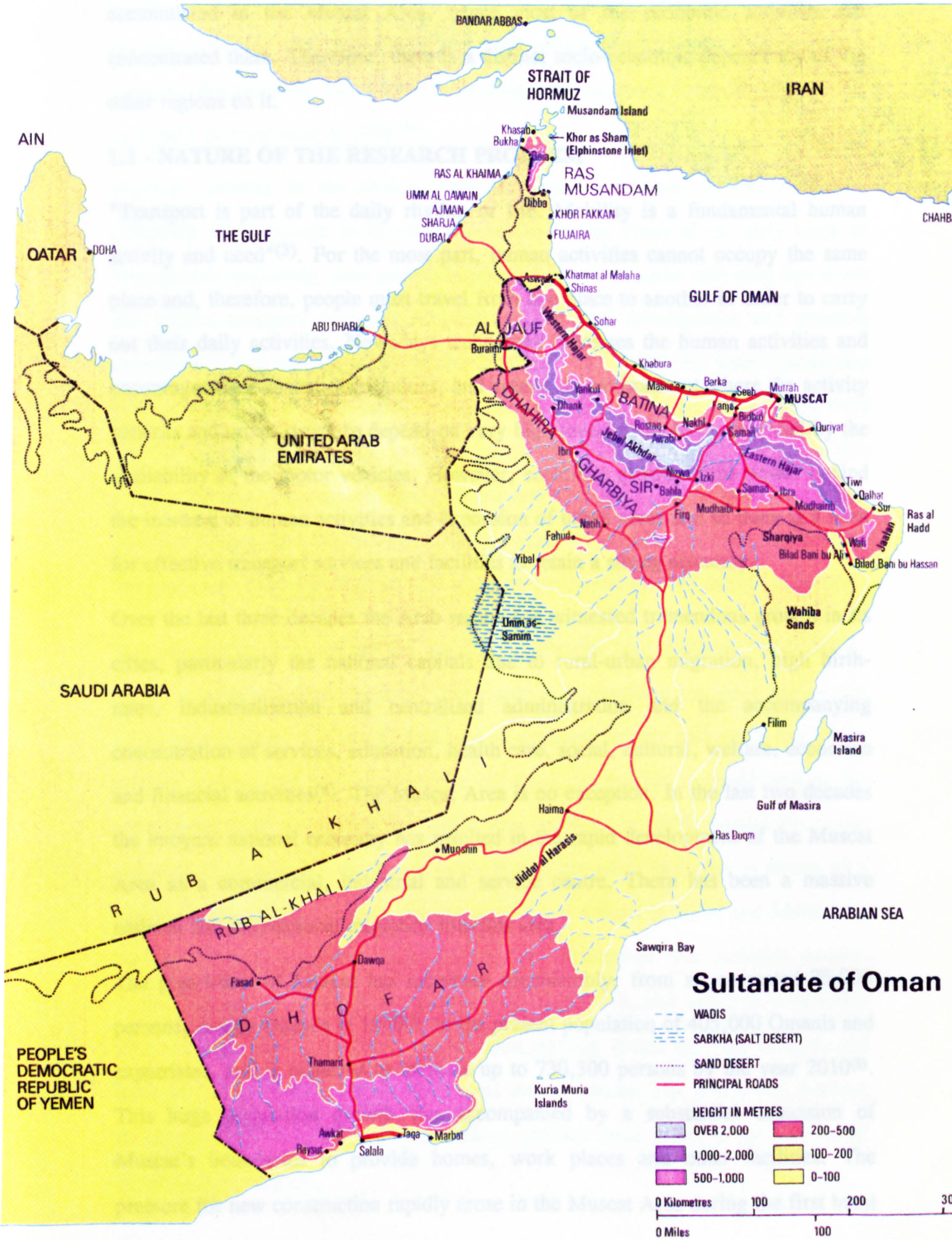


*Figure 1.1:* Sultanate of Oman

accumulated in the Muscat Area, hence most of the economic activities are concentrated there. Therefore, there is a distinct socio-economic dependency of the other regions on it.

## 1.1 - NATURE OF THE RESEARCH PROBLEM

"Transport is part of the daily rhythm of life. Mobility is a fundamental human activity and need"(3). For the most part, human activities cannot occupy the same place and, therefore, people must travel from one place to another in order to carry out their daily activities. Nowadays technology increases the human activities and encourages their spatial distributions, and creates an environment where the activity patterns and urban structure depend on very high levels of mobility provided by the availability of the motor vehicles. However, economic growth is the power behind the increase of human activities and expansion of urban areas and so there is a need for effective transport services and facilities to retain a strong economy.

Over the last three decades the Arab region has witnessed tremendous growth in its cities, particularly the national capitals due to rural-urban migration, high birth-rates, industrialisation and centralised administration and the accompanying concentration of services, education, health care, social, cultural, welfare, economic and financial activities(4). The Muscat Area is no exception. In the last two decades the buoyant national economy has resulted in the rapid development of the Muscat Area as a commercial, industrial and service centre. There has been a massive national and international migration into this area.

The population of Muscat has increased considerably, from an estimated 25,000 persons, mostly Omanis in 1970(5), to the present population of 405,000 Omanis and expatriates, and is expected to increase up to 730,300 persons by the year 2010(6). This huge population growth was accompanied by a substantial expansion of Muscat's boundaries to provide homes, work places and other facilities. The pressure for new construction rapidly arose in the Muscat Area during the first burst of the intensive development after 1970. Construction took place on an ever growing scale and started in the Ruwi valley behind Muttrah toward Seeb area in the west. For example, the number of housing units increased, from 26,176 in 1981 to 50,091 housing units in 1989 [6].

Physical planning in the Muscat Area has been undertaken in the context of extremely rapid change as in most of the developing cities at an early stage of urbanisation, expecting rapid growth in population and area and with only few roads and simple transport systems. A great deal of new development and physical expansion occurs rapidly, which makes it difficult to identify the inter-relationship between transport and land use[7]. Many new roads in the Muscat Area, which were initially planned to function as efficient traffic arteries, failed to achieve this purpose because they attracted new building and commercial activities to their sides. This unforeseen land use pattern tends to unload various slow-moving traffic onto the roads with the result that the new roads normally end up with heavy congestion.

The topographical nature of the area limits the flat land required for housing, shops, schools and other facilities. The resulting competition for space has as one of its consequences that insufficient land is allocated for car parking in the major activity centres. The land allocated for off-street car parking is insufficient in the commercial areas of Muttrah and Ruwi, thus resulting in traffic congestion in the streets in these areas[8]. On nearly every day of the week motorists in search of a parking space can be observed driving around and around in Ruwi and Muttrah in the hope of finding a vacant space near to their destination. The available parking at the present time tends to be uncontrolled, haphazard, and difficult to quantify with any certainty[9]. However, the on-street parking spaces are very limited, and most of the currently used off-street ones are on private lots which are awaiting development, making the expected parking problem even worse in the absence of an immediate solution.

The expansion of the Muscat Area was accompanied by changes in the employment and residential pattern. This has resulted in a significant increase in the number of vehicles, trips and commuting, so the need for effective transport services and facilities is greater than ever before. The topographical features make it difficult to provide sufficient transportation facilities. In addition, the government, in its third Five-Year Plan (1986 - 1990), decided to slow down road building and focus on other priorities such as agriculture and fisheries. In the words of His Majesty Sultan Qaboos on priorities for Oman's third Five-Year plan:

> "We will concentrate more on developing our industry. We can slow down on road building, and schools and hospitals. That does not mean we will stop, but move our attention to other priorities. We must do much more about fisheries, about water development (such as dams), and much more development of agriculture to increase the supply of food(10).

The existing network is dominated by a single east-west traffic corridor with variable sections of two and three-lanes. Brown (1980) observes:

> Muscat's problem is that it is essentially a linear city strung along a narrow coastal plain - the dual carriageway is the only road linking the city centre and all its suburbs, and there is not much space for alternative route(11).

The following observations were made by Dar al Handasah Consultants in the Capital Area Transport Study (CATS) 1985:

> The existing highway network .... has certain structural weaknesses which cause traffic to take indirect routes or use low capacity roads resulting in serious congestion. In particular, there are a number of missing links and bottlenecks. The main strategic weakness of the existing highway network is the existence of only a single corridor in the middle of the Capital Area(12).

The Muscat Area Structure plan (1991) found the CATS observations to be still valid today(13). A clear and readily recognisable road network hierarchy does not exist, and the use of roundabouts without grade separation within the road system makes for bottlenecks, particularly on those with high traffic volumes. This is the case with several roundabouts on the east-west corridor, where considerable traffic congestion is evident at the Burj A'Sahwa roundabout and back traffic on the Seeb approach can be up to 5 km during morning peak hours(14).

The availability of free essential services such as health and education, and no taxes and duties, have led to high household income. Therefore, Muscat is witnessing rapid and successive land-use changes, expansion of the area and multi-car owning households. Based on the Capital Area Transport Study in 1985, the Weidleplan Consultants in their Muscat Area Structure Plan of 1989, estimated that by the end of the planning period in the year 2010 there could be approximately 560,000 vehicles, representing an increase of 509% compared to 1989 (110,000 vehicles). Therefore, the total vehicles/population ratios at 272 per 1000 population in 1989, and 766 per 1000 population in 2010, in which 500 per 1000 population are for private vehicles.

Naturally, the increase in motorisation has consequences for the spatial location and activity patterns. Living away from one's work-place is a normal phenomenon in Muscat, therefore, the number of trips is large and commuting distance is long. Making these trips within the limited major roads that are subject to frequent jaywalking and with the lack of separation between the fast and slow traffic is commonly considered to be the reason for the congestion and most of the traffic accidents. Fawley (1985) commented:

> Flyover, traffic jams and traffic problems - and offences, have now become a part of Omani life as in most other parts of the world, together with only too many motor accidents(15)

The development planning neglected the importance of arranging urban activities which would greatly reduce the need for vehicle movements. It also resulted in low density population areas with street patterns that are not designed for public transport services. Buses and shared taxis tend not to penetrate these areas, but run on the major arterials between the focal centres - Seeb, Muttrah and Ruwi - necessitating long walks. Furthermore, the level of public bus services is very low, most of the nine operating routes are served mostly at hourly intervals(16). The continual stopping of the shared taxis to pick up and set down passengers along the east-west high speed corridor regardless of other road users is considered to be the reason for most accidents and congestion during the peak hours.

On the other hand, privately-hired taxis are not centrally organised and the drivers run their taxis anywhere and at whatever time they wish. They always circulate in the commercial areas of Ruwi and Muttrah, causing more traffic congestion on their streets. Areas away from the commercial centres are poorly served. Anyone wishing to take a taxi must go to the main street, which sometimes requires considerable walking and waiting.

> Paratransit (Private-hire & shared taxis) operators are free to choose vehicles, routes, frequency and hours of operation. The safety standards of paratransit vehicles are often low in large numbers they can cause serious traffic congestion. They compete with conventional bus services reducing the viability of the latter and depriving them of potential passengers and revenue. It is not uncommon to find passenger pick-ups illegally plying for hire in Ruwi Bus Station causing problems to bus operation(12).

In common with many other third world counties, the transport problem in Muscat can be attributed also to the lack of an organisation capable of undertaking transport planning functions. The authorities that share the responsibility have their own priorities, and the problem is exacerbated by inadequate co-ordination and general lack of clarity as to who does what. They do not recognise that transport planning is not an occasional task; that it is a continuing activity, calling for regular data collection, monitoring of programmes and predictions, and updating, modification and implementation of plans(17). Such a transport planning process has not yet been carried out in Oman. The previous studies do not seem to have covered all aspects of the transport system as sometimes they were limited to the field of interest of an individual government agency or responsibility. However, the previous transport studies failed to predict and control urban development and to provide acceptable solutions for transport demand to match the existing and future development. In addition, some of their efforts have been found to be too ambitious, and cost-effective solutions were not considered, hence most of them have been rejected or ignored rather than implemented.

## 1.2 - PREVIOUS STUDIES

There have been several previous studies related to road transport in the Muscat Area, but as mentioned above most of them do not seem to have covered all aspects of the transport system. For example, all previous transport studies undertaken for the Ministry of Housing were within the framework of the previous Muscat Area structure plans and in various local development plans. Thus, they do not deal extensively with the transport problems. They are confined to setting the general corridors for roads. With the exception of the Seeb Municipality road network feasibility study and Capital Area Transport Study, the studies carried out for the Muscat Municipality were in the form of individual road feasibility studies and road design projects. Other transport studies were conducted from an individual point of responsibility. An example of these is An Analysis of Existing Traffic Condition in the Capital Area study(1981), for the Royal Oman Police.

However, the available documents and reports of these studies were reviewed in the early stages of this study, and appropriate information was extracted and used. Road network proposals in these studies were also reviewed and included for assessment in this research. The following studies are worth mentioning:

* *Oman Highway Master Plan: Highway Maintenance Project*

This study was carried out by Dar Al-Handasah Consultants for the Ministry of Communication. The objectives of this study were:

1) - to assist the Directorate General of Roads in the implementation, gathering and maintaining of traffic data for road planning, and

2) - to update the highway user cost study, including gravel roads and to provide estimates of annual budget allocations.

This study commenced in 1978 and was completed in 1981 including roadside interviews, highway network inventories and traffic counts throughout the Sultanate. In 1982-1983 the traffic projections were revised and updated for the third Five Year Plan 1986-1990. Because the Muscat Area road network is not under the responsibility of the Directorate General of Roads, the study did not include the road system within Muscat Area.

* *Capital Area - Muscat Analysis of Existing Traffic Conditions*

This study was conducted by W. D. Scott in association with Transportation Planning Associates (TPA), for the Inspector-General of Police and Customs in 1981. The objective of this study was to provide the Directorate General of Traffic with a basic traffic database and to assist them in alleviating some of the existing congestion. It included roadside interviews, traffic counts and journey time surveys for the development of a traffic model used to forecast traffic growth over two and five year periods (1983 and 1986). The study covered only the area from old Muscat to Adhuba. It made certain short-term proposals for road network development and traffic management.

**Feasibility Study For The Envisaged New Bus Transport Company*

This was prepared by Shair Management Services for the Ministry of Communication in August 1981. The study included bus passenger interviews, passenger counts, and household surveys. Its purpose was to provide the Ministry of Communication with necessary recommendations for the establishment of a new bus company that could replace the existing Oman National Transport Company (ONTC) with a view to improving and extending these services to cover all possible bus routes.

**Capital Area Structure Plan (CASP)*

This was prepared by Llewelyn-Davies Weeks for the Ministry of Land Affairs and Municipalities (now Ministry of Housing), in 1982. It produced a structure plan for the entire Muscat Area, showing the main land uses in relation to the road network. This study provided short, medium and long-term population projections, and land use and housing development required by planning district (5, 10 & 20+ years). Most of the currently valid road network proposals were proposed in this study in order to make up for the principal shortcomings of the existing road system without any quantitative or qualitative assessment. In other words, it was recognised in the Structure Plan that the proposed road network was neither related to any particular time-scale, nor tested to take into account the pattern and size of development within the Muscat Area. Despite the above limitations of the CASP highway network, its proposals form the basis of most current road network proposals.

* *Capital Area Transport Study (CATS)*

This study was undertaken by Dar AL-Handasah Consultants, for Diwan of Royal Court, (1985 to 87). It included roadside interviews, traffic and vehicle occupancy counts, and bus and journey time surveys. The objectives of the study were:- 1) - to develop a strategic traffic model which can be used to test network proposals (mainly the road network proposed in the Capital Area Structure Plan, by Llewelyn-Davies Consultant in 1982) over short, medium and long term planning ( approximately 5, 10 and 20+ years respectively), and 2) - to establish an efficient road and traffic data collection and processing system.

Because the study was limited to the above aspects, transport-related problems were addressed, and further studies were suggested by the consultant. These studies included: traffic management, road safety, parking and public transport study. The consultants also recommended the establishment of a Transport and Traffic Planning

Unit in the Municipality with professional staff within the Projects Department to apply the models when necessary.

* *Muscat Area Structure Plan, Housing Study and Regional Plan*

These were conducted by Weidleplan Consulting GmbH for the Ministry of Housing from 1989 to 1991. Their purpose was to provide information, analysis and recommendations needed to formulate comprehensive short, medium and long-term population projection, land use and housing policy by 23 planning zones. These studies included household, physical and housing policy surveys. The highway network proposed by the Consultants in the Structure Plan and Regional Plan was based on the Capital Area Transport Study (CATS). For some of the proposals, the consultants suggested certain modifications to their proposed alignment or priority without any testing or evaluation of alternative highway options according to the pattern and size of development within Muscat Area.

**Highway Safety*

This study was carried out by Misr Consulting Engineering for the Ministry of Communication in early 1991. The basic aim was to develop the existing accident investigation form in order to build an integrated data base for traffic accidents. It was also intended to set up a plan to improve traffic awareness among the public and to evaluate law enforcement and its efficiency in changing human behaviour. The analysis of traffic accidents was based on statistics derived from the general traffic statistics for the years 1986-1989 published by the Directorate General of Traffic. These statistics do not provide any information to geographically identify the high-risk locations. In order to investigate these locations, the Directorate General of Traffic provided the Consultants with a list of locations of the black spots in the whole country. However, only four black spots were selected for early treatment, within the jurisdiction of the Directorate General of Roads. None of these spots was within the boundary of the Muscat Area.

## 1.3 - OBJECTIVES OF THE STUDY

The increase of the population, household income, car ownership and the expansion of urban area, has resulted in an increased demand for transport facilities over the past twenty years. The downturn in oil prices in 1985 and the country's recession that followed it coupled with the government attention to other priorities, made nonsense of most of the previous transport forecasts, and many transport projects that required heavy investment had to be withdrawn or postponed. The consequences that Muscat faces include delay, traffic accidents and a high demand on parking facilities. The situation is liable to deteriorate sharply in the next few years, unless effective action is taken. In view of the existing problems and the continuing immense growth of the area, there is a need for a study that can provide immediate practical solutions together with guidelines for future policy to ensure that the transport system is expanded and improved in the longer term to cope with the needs arising from future growth.

This study focuses on the Muscat Area road transport problems which are fundamentally similar to problems experienced by many other cities in the world such as traffic congestion, parking difficulties, high traffic accidents and inadequate public transport. These problems are deeply complex now and may increase to a critical level in the future. The main objective of the study is to investigate the existing problems in order to submit appropriate suggestions for their improvement.

There are no waterways or fixed track systems in Oman and the scale of road transport problems is larger than that of air and sea transport, therefore, the focus is on road transportation problems. Within road transportation, the study deals with personal rather than freight movements because the latter is not as significant in Oman as it is in the industrial countries. The time limit is also another factor which confined the study to the problems of personal movements in the Muscat Area.

There are two issues addressed in this study. The first one deals with the identification of the factors that contribute to the existing road transport problems through the interpretation of the recent evidence and analysis of data collected in the fieldwork. The second issue is to provide useful information for transport planners and decision makers in understanding the nature of the problems and finding acceptable solutions and guidelines for future policy.

This research attempts to answer the following questions:

1 - What are the trip characteristics in the Muscat Area? (i.e. travel origins, destinations, purposes, travel mode)

2 - To what extent do the natural topographical features inhibit the development of the Muscat road network?

3 - How does the network currently serve the needs of the area and how far can it cope with the traffic movement?

4 - Will the proposed major roads solve the present problems of traffic congestion and alleviate future ones?

5 - What is the impact of the motor vehicle on the Muscat Area and what are the main causes for traffic accidents?

6 - To what extent are parking facilities adequate at the major activity centres?

7 - What is the role of Oman National Transport Company (ONTC) buses within the public transport system?

## 1.4 - METHODOLOGY

Because social, economic, and topographical conditions vary from city to city, urban transport problems cannot be solved by the adoption of ready-made, universal policies[18]. Unfortunately, the detailed methodologies best suited to the conditions of developing-country cities are far from clear[17]. Therefore, the methodology is directed toward developing an understanding of the characteristics of the traffic movements, and identifying the factors that contribute to the existing transport problems by making optimum use of the available information together with the data collected during the field-work surveys.

To satisfy the aim of the study, it was essential to recognise that effective recommendations would not be achieved without investigating past and current planning efforts that are available (both policies and implementation). For a study of this nature a wide range of data is required to identify and analyse the potential deficiencies of the present transport system in such a way as to simplify finding effective solutions. For example, information was required on the following:-

1 - Traffic flow, congestion and composition during peak and off peak periods.

2 - Availability and utilisation of parking spaces.

3 - Condition of pedestrian facilities and data on accidents.

4 - Facilities and performance of public transport.

5 - Characteristics of population, employment, household income, land-use and car ownership associated with the types of journeys made.

5 - Pattern of movement of personal travel, principal modes of travel used, and reasons for travel and times of day at which it occurs.

Data collection was based on library search and extensive fieldwork. The fieldwork involved direct contacts with relevant authorities for the review and collection of existing data, and the administration of four questionnaires. The objectives of the direct contacts method were: (1) to keep the research in line and updated with the recent relevant studies and (2) to locate types of data that are available without conducting further surveys to satisfy the research requirement. So, many recent and previous reports, studies, statistics and plans were collected from government departments and various private institutions

### *1.4.1 - TRAFFIC SURVEYS*

Having defined the available data, it was necessary to conduct several surveys. It was important to ensure compatibility of the data, and to put together the procedure adopted for the design of the questionnaire and method of survey to obtain as much reliable data as possible. These surveys had two purposes: (1) to collect information that could identify clearly the various factors that were, or might have been, contributory to the present problems, since there was a lack of information to provide a detailed picture of the transportation system in the Muscat Area, (2) to provide a base from which predictions of the future could be estimated, and means of comparison and assessment could be made. Four types of survey were conducted on weekdays and these are summarised below ( see Appendices A, B, C and D).

#### 1.4.1.1 - HOME INTERVIEW

The home interview was adopted to collect the maximum amount of information from the residents of the study area. This survey covered 528 households, in which 2662 persons were interviewed. It had two objectives: (1) to collect information relating to the household characteristics and household members' attitudes toward public transport, (2) to provide a detailed picture of typical weekday person trips in terms of origins, destinations, purposes and modes of travel in addition to information on the time of start and end of trips, the vehicle occupancy and the duration and type of parking at destination. This information was necessary to estimate traffic flow and travel choices, and to distinguish journeys between all types of terminals and activities.

#### 1.4.1.2 - ROADSIDE INTERVIEW

Eight hundred and twelve drivers were interviewed with the purpose of collecting information about the volume, composition and pattern movements of traffic entering the Muscat boundary, known as external trips, thereby, counting vehicles and interviewing a sample of drivers at cordon points in their journey into the study area. The survey was intended to provide detailed information in terms of trip origins and destinations. Therefore, data were collected on the trip purpose, number of stops during the journey, vehicle occupancy, and duration and type of parking at their destination.

1.4.1.3 - PARKING SURVEY

Determination of the need for parking surveys must be based on reliable data on the demand for parking, and on the supply of existing facilities(19). Parking surveys were carried out in Ruwi High Street, Muttrah Corniche and Central Business Area, where parking is a serious problem. The purpose of parking survey was to obtain the information necessary to provide an assessment of the parking problem in these areas. Three types of survey were carried out:

I- *Parking Duration Survey*:

The purpose of this survey was to estimate the average duration of parking and variation by vehicle types. Two methods were used:

a - *Patrol survey:* This method was for an on-street parking. The approach involved an observer walking around a section of 20 parking spaces at 15 minute intervals in two locations in Muttrah and Ruwi shopping areas. The survey was designed to obtain information on the total number of parkers, parking duration and accumulation, arrival and departure rate, and type of vehicles parked.

b - *Registration Number Survey:* This was for an off-street parking survey in one location in Ruwi shopping areas. Two observers recorded vehicles entering and leaving the car park by 15 minute intervals. The data collected were similar to those of the patrol survey.

II- *Parking Accumulation Survey*

The purpose of this survey was to provide an estimate of the total parking spaces available, the total vehicles parked and methods of parking. As there was a lack of parking inventory and parking control, an aerial survey was conducted to cover specific zones in those areas.

III- *Questionnaire*

A reply-paid Questionnaire was administrated in two of the areas that were covered in the aerial survey. It was designed to provide a clear picture of the parking difficulty and traffic congestion in the selected areas. the responses received were 613. Data were collected about trip origins, destinations, purposes and mode of travel. In addition, data were obtained on vehicle occupancy, duration, type of parking and walking distance to destination, as well as personal attitudes towards and opinions on the problem.

1.4.1.4 - BUS PASSENGER INTERVIEW

The interviews were carried out with 884 passengers on board the ONTC buses within the study area. Data were collected on trip origin, destination, purpose, and personal information and opinions. In addition to counting the number of passengers boarding and alighting, information was collected on the mode and time of travel to and from the bus stop, and waiting time at the bus stop.

### *1.4.2 - ACCIDENT DATA COLLECTION*

The police statistics on road traffic accidents provided information on the total number of accidents, their time and circumstances, type of road, and road user. The lack of information to identify high-risk locations made it necessary to collect accident details from the police files. Details of injury accidents reported to the Police in 1990 were transcribed onto coding sheets.

In addition, colour photographs were taken extensively during the fieldwork in order to support statements that might otherwise seem exaggerated. Automatic traffic counts were also carried out by British Petroleum Company in September 1990 to collect 24 hour traffic flow at key points located by the researcher.

### *1.4.3 - DATA ANALYSIS*

Conventional traffic modelling techniques have been developed and applied in cities and regions of industrialised countries in Europe and North America, where change is gradual and there are adequate socio-economic and land use data as well as an established street referencing and address system. As a result, a fairly satisfactory relationship between travel demand and planning variables is established and used to make travel forecasts, despite some uncertainty due to unforeseen economic problems.

However, from the experience of the past 30 years in planning methodology in developed countries, transportation planners realised that the quality of results expected from sophisticated models is chiefly dependent on sound and reliable data [20]. In developing countries with much more uncertainty concerning future growth, income and land uses, these models seem even less appropriate[16]. Unlike industrialised cities and regions, change is more rapid and less predictable in a developing city such as the Muscat Area. Therefore, a full application of the four-step sequential models of trip generation and distribution, modal split and traffic assignment, was not considered as an appropriate approach for two reasons. First, such models are highly sophisticated; they require considerable resources and collection of a large amount of expensive data which was beyond the means of the researcher. In a developing country such as Oman, there is a lack of data-collection system and very few relevant studies have so far been conducted. Second, the study is primarily concerned with the existing transport problems, and the improvement of the transportation facilities to meet the demand, rather than to fulfil the demand of data-hungry models that have been frequently criticised by many reviewers for their full application in the developing countries.

Arguably, the problems seem to be clear enough without the use of models requiring statistical data and information sources, some of which are scarce in Oman. A more appropriate approach would be tailor-made models, capable of reflecting the particular conditions of the Muscat Area and commensurate with the available data. Therefore, such models were adopted where necessary to give a faithful general representation of the transportation condition and to provide a comprehensive treatment for each problem within the optimum use of the available resources. The following is a brief description for some of the techniques of analysis used in this study.

#### 1.4.3.1 - TRIP GENERATION ANALYSIS

Category analysis models were adopted. The models presented a cross-tabulation of trip rates, in terms of one or more socio-economic and demographic characteristics of a household. This seemed to be an effective way of expressing the variation in traffic generation between different types of households in the area. This approach was adopted for three reasons. First, it does not require a large sample of home-interview per traffic zone to estimate trip rates, since this procedure considers the household as the fundamental unit of analysis. Second, it makes efficient use of the estimated household categories per traffic zone in the Muscat Housing Study 1989. Third, a powerful computer data-base (Oracle) that can meet the models' requirement is available (see section 1.5).

#### 1.4.3.2 - TRIP DISTRIBUTION

Observed trip matrix tables were used to obtain all the trips from each origin to every destination defined in the study (mode of travel and trip purpose) directly from the surveys. The desire-line diagrams proved more practicable in showing the origin and destination pattern of movement in the municipalities level due to the geographical nature of the area. In view of the available data a very simple projection of future trip movements between the municipalities was estimated, using the Furness Method. In this the growth factors of trip generation and attraction are estimated on the basis of the research results in conjunction with the Muscat Area Structure Plan land-use development strategy(see Chapter 5).

### 1.4.3.3 - ACCIDENT ANALYSIS

Traffic accidents and their human casualties have not been extensively studied in Oman in general and in the Muscat Area in particular. Therefore, the readily available aggregate data source was used to look at the entire problem. To obtain a more complete understanding, it was necessary to examine the causes in depth, using the aggregate data sources with the information collected during the fieldwork. The intersection between road environment, vehicle and the road user was investigated for the purpose of accident analysis.

### 1.4.3.4 - PARKING ANALYSIS

There was a lack of information on existing parking facilities. Therefore, the analysis concentrated on the information collected from the selected locations during the fieldwork. Measurements such as parking accumulation, volume, turnover and duration were used to assess the parking characteristics of vehicles, such as the time, place and duration of parking. The analysis shows the effect of trip purpose and walking distance on parking duration. This assessment was then used to provide guidelines for general parking policy in which both the parking space available and duration of use of those spaces can be controlled.

### 1.4.3.5 - PUBLIC TRANSPORT ANALYSIS

The analysis covers in some detail the physical characteristics and conditions of the public transport system in the study area. The survey data together with demographic information were used to estimate the suitable operating environment and method for each type of public transport according to the present and the expected future demand. The focus is on the Oman National Transport Company "ONTC" bus routes to formulate recommendations that can, hopefully, improve the role of the bus system.

## 1.5 - DATA PROCESSING

The readily available computer packages for transport and traffic analysis are designed to analyse data that have been coded in a standard format. For example, the Roadway Suite was designed to meet data coding and planning parameters of the department of transport in the UK. Indeed, the existing programs require a range of amendments to be made in order to ensure that the processing and analysis of the available data is logical and comprehensive. For this reason, the existing computer packages were considered inappropriate. It was necessary to develop alternative programs to serve the purposes of maintaining a database for creating, querying and updating data relating to:

1- Home Interview Survey
2- Roadside Interview Survey
3 - Accident Data collection
4 - Reply Paid Questionnaire Parking Survey
5 - Registration Number parking survey
6 - Bus Passenger Survey

The application platform for the system is the Oracle Relational DBMS. This platform has been used keeping in mind: 1) powerful facilities for entry, update and enquiry; 2) ad-hoc querying with simple commands; 3) flexibility of analysis and generating a variety of simple and complex reports. So Oracle provides the most convenient platform for meeting these needs for the survey analysis, since the application base itself is evolving and the reporting requirements may be varied and may expand. In Oracle, all the data are stored and displayed in tables which can be connected to increase their usefulness and to avoid duplication.

The development of the system began simultaneously with the development of the survey questionnaires over the period of the fieldwork in Oman 1990. With assistance from the Directorate of Computers of the Royal Oman Police, a great deal of effort and time was spent in producing appropriate programs capable of meeting the requirements of data handling and analysis. The following is a brief description of the system.

Data can be entered into the form directly. A menu was made to facilitate entry and suitable prompts were provided to assist wherever possible. Comprehensive validation checks were built into the system to ensure that invalid data were not entered into the system. To minimise the data entry time into the computer, the surveys' data were provided with numeric codes. Depending upon the number of persons in the survey category, the form would automatically ask for data for appropriate number of persons.

Query mode, invoke the form as before, a query command key which would present the query mode of the forms on the screen was provided. The updating of data could be performed on these records retrieved through query. Values in the various fields could be updated by overwriting the existing values. Deleting is possible at the record level in all the blocks. For example, the Home Interview Survey Form was set up using three tables, the delete operations in the blocks Homel and Home2h is provided with cascade effect. This means that when a record is deleted in Homel the corresponding related records in blocks Home2h and Home3t are automatically deleted. This was done to ensure consistency of data recorded in the three tables.

## 1.6 - STRUCTURE OF THE THESIS

The problems of the road transportation system in the Muscat Area and some of their possible solutions are discussed in nine Chapters. The present Chapter presents the statement of the problem, the objectives of the study and the methodology adopted for data collection and analysis. *Chapter Two* deals with the physical aspects and development characteristics of the Muscat Area. This chapter presents the results of basic planning data reviewed to measure certain factors related to the development characteristics of Muscat. Those factors are required for the purposes of travel data analysis and are necessary for understanding and determining travel movement characteristics. The main issues discussed are: the geographical setting - including location, topography, climate and traffic zones - population, land use, household size and income, employment, and car availability. *Chapter Three* deals with the characteristics of personal travel in the study area. It begins with the question of where people travel including classification of travel movements, and the length, duration and geographical distribution of trips. It also discusses why, how and when people travel together with trip generation rates.

*Chapter Four* illustrates how the existing road network currently serves the needs of Muscat Area, and how far it can cope with traffic movements. The early part of the Chapter describes road network development and identifies major Muscat road network planning issues and planning policies, including planning organisations, and road planning and project implementation problems. Looking at the Muscat Area road network, the present and potential deficiencies are examined, some of which show signs of significance such as insufficient local access and roads in the major commercial to areas, traffic congestion and accidents, and the dependence upon the dual carriageway (east-west corridor) as the only principal route through the Muscat Area. The major issues and policy options for development of the Muscat Area road network are discussed.

*Chapter Five* is devoted to the currently proposed major road networks. It reviews the previous major highway network proposals and gives advice on their priories in the light of the analysis of the data gathered for the purpose of this study. It also reviews the concept of future development strategy and the structure of the urban areas in the Muscat Area. *Chapter Six* discusses the impact of the motor vehicle. It begins with problems of congestion, noise and air pollution. It focuses on traffic accidents in order to identify the factors that contribute to traffic accidents and to present appropriate suggestions that can help in reducing the number of accidents and providing guidelines for accident prevention.

*Chapter Seven* deals with parking characteristics and facilities in the Muscat Area in general and around the major shopping and business areas in particular. Measurements such as parking accumulation, volume, turnover and duration are used to assess the parking characteristics of vehicles, such as, where they are parked and for how long, the effect of trip purpose and walking distance on parking duration. It also discusses the availability of parking space in terms of parking type and the characteristics of traffic flow to and from the shopping areas ending with appropriate recommendations.

*Chapter Eight* describes the existing public transport system in the Muscat Area. It begins with the various forms of public transport discussing the role of each mode, its operation and the associated problems. It focuses on public bus transport covering in some detail the physical characteristics and conditions of the bus service, and shows the public attitudes towards the bus transport. It also discusses the problems that face the potential public transport users and puts forward suggestions that may improve the role of public transport. *Chapter Nine* is the final chapter and it is devoted for the summary of the research main findings.

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# CHAPTER 2

## ASPECTS OF THE PHYSICAL AND DEVELOPMENT CHARACTERISTICS OF MUSCAT AREA

### 2.0: INTRODUCTION

The transportation planning process makes use of the relationships that exist between the movement of people and those measurable human activities that are reflected in the pattern of urban development. This chapter presents the results of basic planning data reviewed to measure certain factors related to the development characteristics of Muscat. These factors are required for the purposes of travel data analysis and necessary for understanding and determining travel movements characteristics.

The degree of emphasis placed on the study of each development factor varied considerably and was determined by its relative importance to the traffic movement within the available sources of information. Basically each trip has two ends: a generation end and an attraction end. The generation end normally relates to people's residences and the attraction end to an activity. So as to develop the relationship, it is necessary to assemble data concerning the nature and quantity of each type of generation and attraction factor at the municipality level. Gathering data in traffic zone level was not considered as an appropriate approach due to the amount of work required, besides, there is a shortage of some of the available data. The main planning data include physical context, population, land use, household size, household income, employment and various factors affecting car availability.

Apart from the 1990 fieldwork traffic surveys, many sources were used in obtaining the planning information, the principal of these were recent Ministry of Housing studies, such as, the Muscat Area Structure Plan, the Housing Study and Regional Plan. In addition, valuable information on related subjects was provided by many government ministries and various private institutions.

## 2.1: THE PHYSICAL CONTEXT

### 2.1.1: *LOCATION*

Between the north west - south east trending Oman mountains in the south and the Gulf of Oman in the north lies the narrow coastal belt of Al-Batinah. It is at the eastern end of this plain that the Muscat Area is located, (see *figure 1.1*). Muscat spreads over 80 km along the country's northern coastal line from Manuma on the border of Al-Batinah region in the west to Shifa in the south-east near the border of Quriyat. From north to south the extension is of about 20 km in Seeb and between 45 and 50 km in Greater Muttrah and Al-Amarat respectively. The Muscat Area Structure Plan, 1989, estimated the total area at 2,300 sq. km, of which 150 sq. km is developed, while the rest of the total area is mostly dominated by Al-Hajar mountain and flood prone areas(1).

### 2.1.2: *TOPOGRAPHY*

Muscat has a uniquely complex topographical area of ragged mountains, wide valleys, and a narrow coastal plain interrupted by foothills. The topography has been a major factor influencing the urban pattern and expansion of the Muscat Area. It has restricted the urban expansion to a linear fashion, occupying a narrow (5 to 8 km) coastal strip between Al-Hajar mountain and the Gulf of Oman(2). The development was started from the historical town of Muscat towards the west, and up the foothills of the Al-Hajar mountain. In the east, Al-Hajar mountain reach the sea leaving almost no space for development towards south-east.

The topographical nature of the Muscat Area, coupled with the channel development along a series of valleys, large bowls and a narrow coastal plain indicate a linear road pattern with access roads connected to it at several points. The east-west corridor still forms the shape of the Muscat Area highway network.

## 2.1.3: *CLIMATE*

Oman lies in a transitional climate zone, between the equatorial and mid latitude climate, which is characterised by low rainfall and high temperature[3]. However, the climate varies considerably from region to region. The coastal area is very hot and humid during the summer months while the interior is dry. Local climate in the Muscat area is influenced by its coastal location. Although it is described as being semi desertic there is a large degree of local variation that makes prediction for specific areas uncertain. Climatically, however, Oman has a less savoury reputation than perhaps it deserves. The Arab geographer Abdul Razak wrote of Muscat in the fourteenth century with some hyperbole:

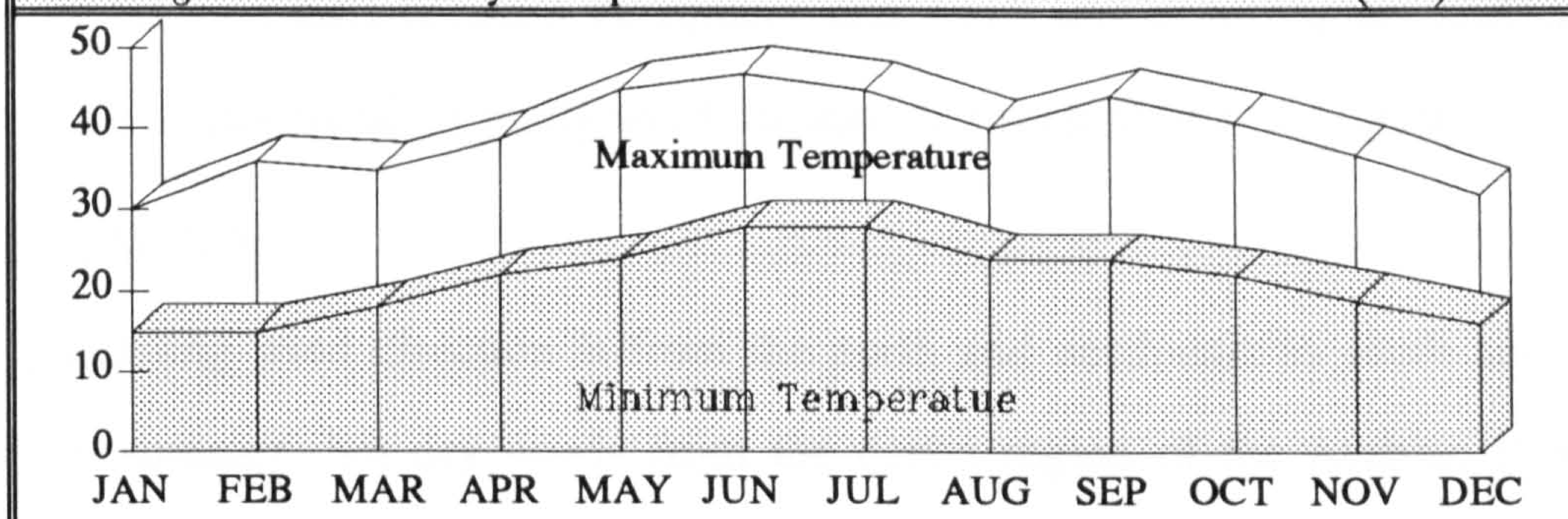
> The heat ... was so intense that it burned the marrow in the bones, the sword in its scabbard melted into wax and the gems which adorned the handle of the dagger were reduced to coal.[4]

### 2.1.3.1: TEMPERATURE

In summer, the sun is directly overhead and daily sun hours are high, therefore, many literary passages refer to Muscat as the hottest place on earth[5]. The fact is that during April to October the daily average Maximum temperature in Muscat is 42°C. It reaches as high as 47°C at times during June and July. The average minimum temperature during the same period is around 24°C. During November to March the average maximum is around 33°C, and the average minimum is around 16°C.

The surrounding hills and lack of vegetation in the city reflect the sun's heat, which helps to raise the temperature to its maximum between 12.00 p.m. and 4.00 p.m. Traffic movement tends to decrease during this period of the day and people prefer to stay indoors. *Figure 2.1* Shows the monthly maximum and minimum temperature as it was recorded at Seeb International Airport in 1989.

*Figure 2.1* : Monthly Temperature. in the Muscat Area in 1989(0C)

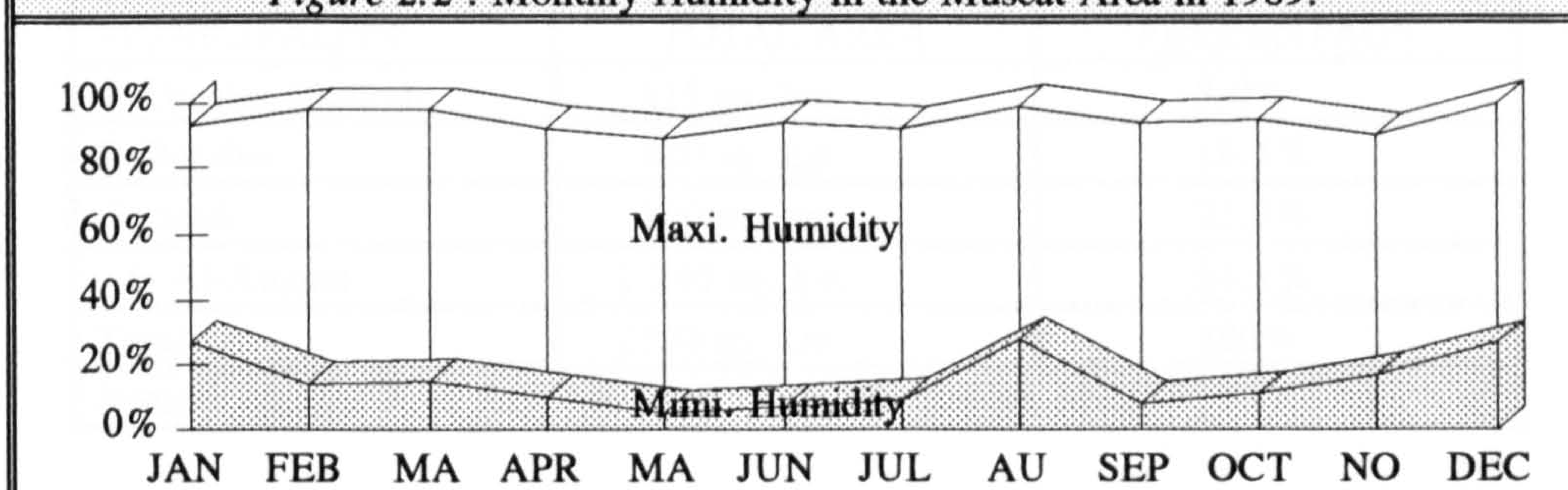



Source: Sultanate of Oman, Statistical Year Book, June 1990, p 13. "Own calculation"

2.1.3.2: HUMIDITY

Throughout the year, the average maximum humidity is generally high, being in range of 83 - 100 per cent, and the average minimum is around 15 per cent. *Figure 2.2* shows the monthly maximum and minimum humidity in 1989. The highest maximum humidity was recorded in December (100%). The lowest Humidity was 83 per cent in January.

*Figure 2.2* : Monthly Humidity in the Muscat Area in 1989.




Source: Sultanate of Oman, Statistical Year Book, June 1990, p 14. "Own calculation"

2.1.3.3: PRECIPITATION

The annual rainfall recorded at Seeb Airport ranged between 196.3 mm in 1987 and 69.9 mm in 1989. The mean annual precipitation for the Muscat Area is very low at just over 100 mm. In Al-Hajar mountain to the west and south up to 300 mm mean annual precipitation could be expected. Nearly all of the rainfall occurs as intense storms and often over small localised areas which can produce violent flash floods.

Most of the rain falls between November and April and in infrequent and isolated conventional storms of normally short duration between May and August.

2.1.3.4: WINDS

The prevailing wind direction is from the north and north-east to south and south-west. In summer, hot dry winds from the desert region of the Arabian Peninsula (south-west direction) cause very high temperature. The average wind speed is generally less than 10 knots but speeds of up to 57 knots in gusts have been recorded.

2.1.4: *SPATIAL DELINEATION*

Administratively, the Muscat Area is subdivided into four municipalities: Greater Muttrah, Boashar, Seeb and Al-Amarat. The area sizes for the four municipalities are given in *table 2.1,* and their extension is shown in *figure 2.3.*

*Table 2.1:* Sizes of Municipalities

| MUNICIPALITY | TOTAL AREA | PERCENTAGE |
|---|---|---|
| 1- Greater Muttrah | 115 sq. km | 5.0% |
| 2- Boashar | 420 sq. km | 18.3% |
| 3- Seeb | 520 sq. km | 22.6% |
| 4- Al-Amarat | 1,245 sq. km | 54.1% |
| Total | 2300 sq. km | 100% |

Source: Muscat Area Structure Plan 1989, Weidleplan-Muamir, P17.

Greater Muttrah encompasses the historic centres of Muscat and Muttrah, traditional coastal villages along the east coast, and the bulk of modern development filling Ruwi valley. Muttrah extends from Darsait village in the west to Quntab in the east and southwards to the edge of Al-Hajar Bowl. The area is heavily constrained by internal mountain ranges. Almost all development land is committed and further growth must be through reconstruction at higher densities. Although this municipality occupies only 5 per cent of the total area, it currently contains mostly 39 per cent of the population in the Muscat Area. Most of the Muscat Area commercial functions are concentrated in this municipality.

Boashar municipality contains the new growth poles of residential development at Wattayah, Qurm, Qaboos City, Al-Khuwair and Adheiba. This municipality, stretching from Wadi Adai to Airport-heights, developed as a series of residential communities at low to moderate densities, accession to the commercial, industrial and government centres in Ghala and Al-Khuwair.

Seeb municipality stretches from the Seeb International Airport in the east to Manuma on the border of Al-Batinah region in the west. It lies at the junction of roads to the Muscat Area, A'Dakhliya and Al-Batinah, and contains the traditional farming and fishing communities within the coastal green belt of palm plantations of Seeb, Hail and Mabila north. Inland, there are the new residential communities of Al-Khod, Mabila south, Qaboos University campus and Rusail industrial area.

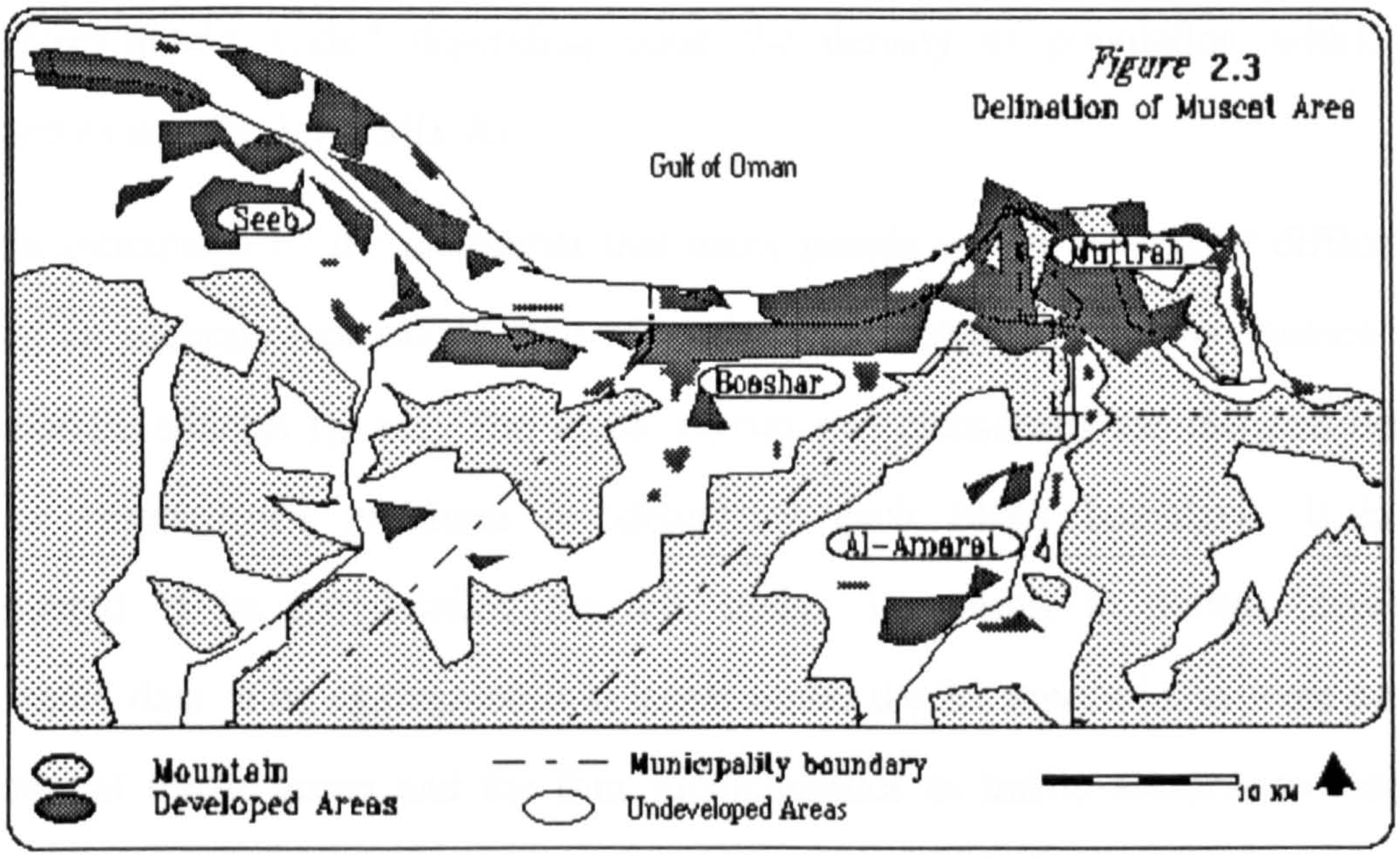


*Figure* 2.3
Delination of Muscat Area

Al-Amarat municipality contains traditional rural settlements and the new residential communities of Al-Amarat, Al-Nahda City and Wadi Hattat within Al-Hajar Bowl. This bowl of large open land, surrounded by the mountain ridge of Al-Hajar, is south of Greater Muttrah. The only link between the bowl and the rest of the Muscat Area is through a single carriageway in the steep sided Wadi Adai gorge.

## 2.1.5: *TRAFFIC ZONES*

In transport planning terms, the Capital Area could be best defined as a region rather than as an urban conglomerate. Within the region there are few well defined areas and communities of various sizes(6). To study traffic movements between these areas and the areas outside the external cordon, it was necessary to convert all areas into geographical traffic zones.

In 1985 the Diwan of the Royal Court, Muscat Municipality, Directorate General for Technical Affairs introduced a system of street and house numbering. This system is based on a Block-System, where the entire development part of Muscat Area is divided into more than 200 blocks. In the 1989 Muscat Area Housing Study, Weidleplan Consultants grouped the blocks to 25 super-blocks. The sizes of the super-blocks varied depending upon the density of population within well defined areas (see Appendix A).

It was anticipated by the researcher that many people would have great difficulty in giving an accurate location of their trip origin and destination in the absence of an appropriate address system. The Block-system was considered too difficult because of the respondent's problems in identifying each Block boundary. It is also considered to be too detailed for this study. Therefore, to permit travel and household data to be aggregated into larger units, the 25 super-blocks were adopted as internal traffic zones and the four municipalities as traffic sectors, so that data processing could be reduced to manageable size (*Figure 2.4*).

External traffic zones were established in the country regions and neighbouring countries. A total of 8 external traffic zones were adopted, representing zones from 26 to 33. The traffic zones from 26 to 31, represented the remaining 6 regions of the country, while zone 32 is for United Arab Emirates, 33 for other countries.

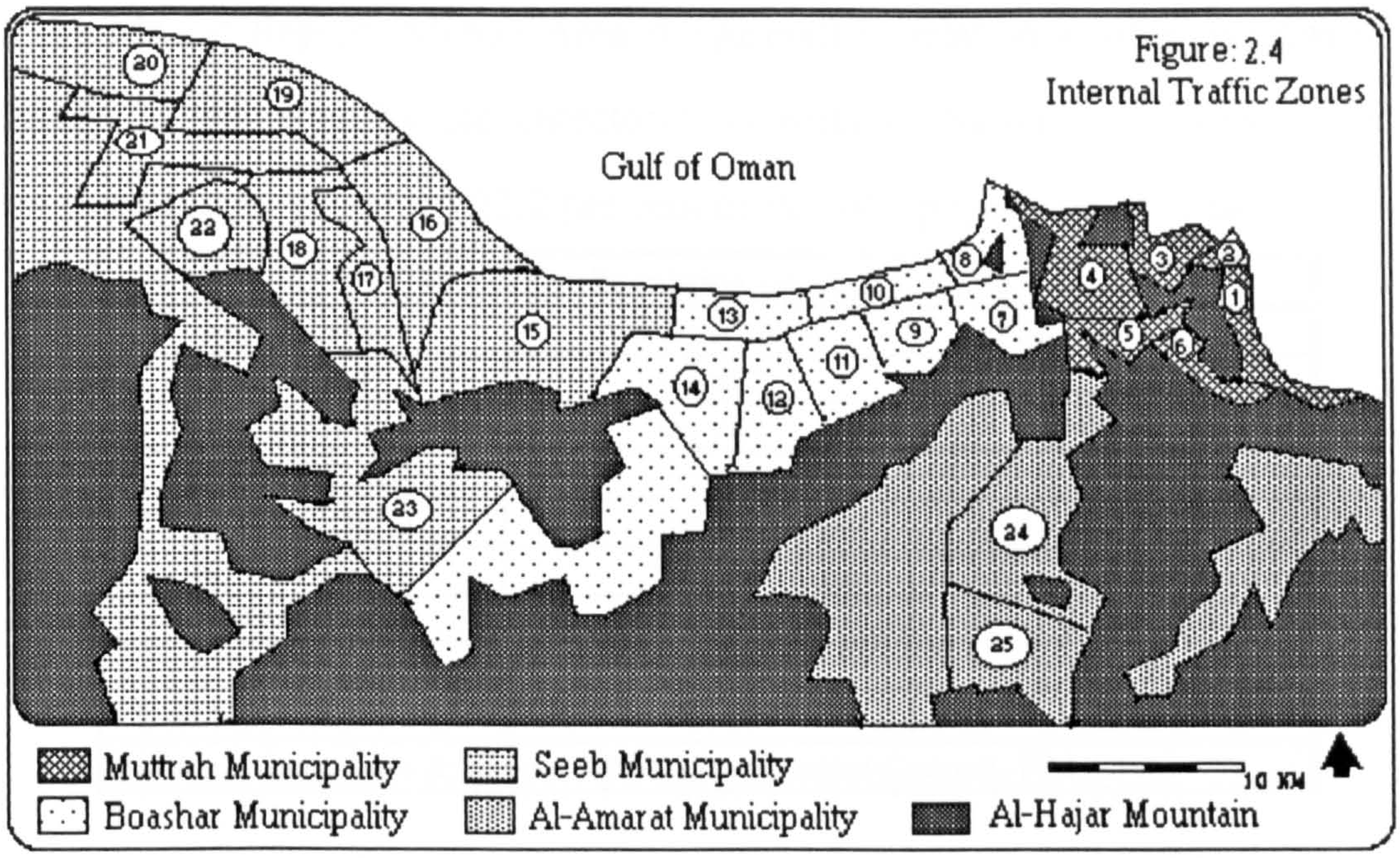



Figure: 2.4
Internal Traffic Zones

| | | | |
|---|---|---|---|
| 1 - Sidab, Bustan, Quntab | 7 - Wattayah | 13 - Adhuba 14 - Ghala | 20 - Manuma |
| 2 - Muscat town | 8 - Qurum | 15 -Airport & Ai't Hights | 21 - Ma'abila |
| 3 - Muttrah town | 9 - Qaboos, City Int. City | 16 - Mawelah | 22 - Qaboos University |
| 4 - Darsait, Ruwi N.CDB | 10 - Qurum Beach , Dip Area | 17 - Al- Hail | 23 - Rusail Industrial |
| 5 - Ruwi S, Hamriya, Wadi adai | 11 - Al-Khuwair | 18 - Al-Khod | 24 - Al - Amarat town |
| 6 - Wadi Kabir | 12 - Ghabra, Boashar | 19 - Seeb town | 25 - Madinat Al-Nahda |

## 2.2 - POPULATION

### 2.2.1: *EXISTING POPULATION*

People are the basic underlying source of travel. Thus detailed information on the magnitude and distribution of population is of prime importance in the process of understanding the travel characteristics. Demographic data are usually obtained from a national census. Unfortunately a full census has not been carried out in Oman yet. The population of the Muscat Area in 1989 was estimated at 405,278 by the Weidleplan Consultant(7).

The population estimate was based on a detailed residential dwelling count, conducted by Weidleplan Consultant, multiplied by likely occupancy rates based on spot survey per super-block and dwelling type. People living in bachelor accommodation, dormitories, labour camps and villages outside the boundaries' block-system were counted separately. *Table 2.2* shows 1989 population statistics for the Muscat Region (Muscat Area + Quriyat) in relation to other regions of the country, as estimated by the Directorate General of National statistics. It can be seen that Muscat contained 22.2 per cent of the total population of Oman.

*Table 2.2* : Population estimate of Oman

| REGIONS | POPULATION | PERCENTAGE |
|---|---|---|
| MUSCAT | 444 472 | 22.2 % |
| AL-BATINAH | 581 968 | 29.1 % |
| A' DAKHLIYA | 253 684 | 12.7% |
| A' SHARQIYA | 290 784 | 14.5 % |
| A' DHAHIRA | 180 781 | 09.0% |
| MUSANDAM | 031 766 | 01.6 % |
| DHOFAR | 216 546 | 10.8 % |
| Total Population of Oman | 2 000 000 | 100 % |

Source: Oman facts & figures, 1990, Development Council, P24.

It is worth mentioning that there is a huge difference between the population of the Muscat Area (the capital of the country) and the population of Salalah the next largest city in Oman (Salalah population estimated at 72,152 in 1991)[(8)]. So the Muscat Area has a dominant role in the country, due to concentration of services, education, health care, social, cultural, and economic and financial activities.

2.2.2: *POPULATION DISTRIBUTION*

*Table 2.3* shows the distribution of the 1989 population estimated in the Muscat Area by municipality. It shows that Muttrah municipality has about 39 per cent of the total population. Around 56 per cent live in single units, 39 per cent are in flats and only 5 per cent of the total population in Muttrah are living in labour accommodations. Boashar municipality has the highest share of population living in labour accommodations, about 22 per cent. The share of people living in flats in the Seeb municipality is comparatively low, reaching only 8 per cent. Al-Hajar municipality comprises only 8 per cent of the total population. Almost 40 per cent of the inhabitants reside in remote villages throughout the area which stretches beyond the developed areas covered by the block system.

*Table 2.3* : Population in 1989 by municipality

| Municipality | Number of Persons | | | | | Total Population | |
|---|---|---|---|---|---|---|---|
| | *Single Units* | *Flats* | *Villages* -*- | *Labour acco't* | *Others* | *Number* - * * - | *Percent* |
| 1- Muttrah | 87431 | 60386 | 0.0 | 8362 | 0.0 | 156179 | 39% |
| 2- Boashar | 51306 | 25341 | 2820 | 22603 | 3000 | 105070 | 26% |
| 3- Seeb | 87063 | 8662 | 2900 | 7641 | 3389 | 109655 | 27% |
| 4- Al-Amarat | 18327 | 379 | 13700 | 1968 | 0.0 | 34374 | 08% |
| Total | 244127 | 94768 | 19420 | 40574 | 6389 | 405278 | 100% |

Source: The 1989 Muscat Housing Study, Own calculation.
- * - Outside the block boundaries but within the Muscat Area
- ** - People living in restricted areas are not included

## 2.2.3: *POPULATION DENSITY*

The number of journeys generated in an urban area is obviously directly related to the number of persons residing in that area. Generally, other things being equal, where there are more people, there is bound to be more traffic, and where there are fewer people, there will be less traffic movement.

*Figure 2.5* illustrates the distribution of population in the Muscat Area in terms of persons per hectare. The density of the residential development varies widely from area to area. The highest concentration of population can be observed in parts of Muttrah. In commercial areas the densities are higher than those in the planned upper class residential areas in Boashar. In Seeb, the densities vary from low to high. The higher densities are found in Seeb centre, Sheradi and parts of Al-Khod while in Al-Hail North and Mabila South, the densities are moderate. Low densities are observed in areas with scattered development and garden villa-type housing. In Al-Amarat, the densities are low to moderate.

The density map reflects, to an extent, the age of the development and it will be noted that though the density of the population is high in the older developed areas, such as in Muttrah municipality and Seeb town, the areas of more recent development have been, in general, at lower density.

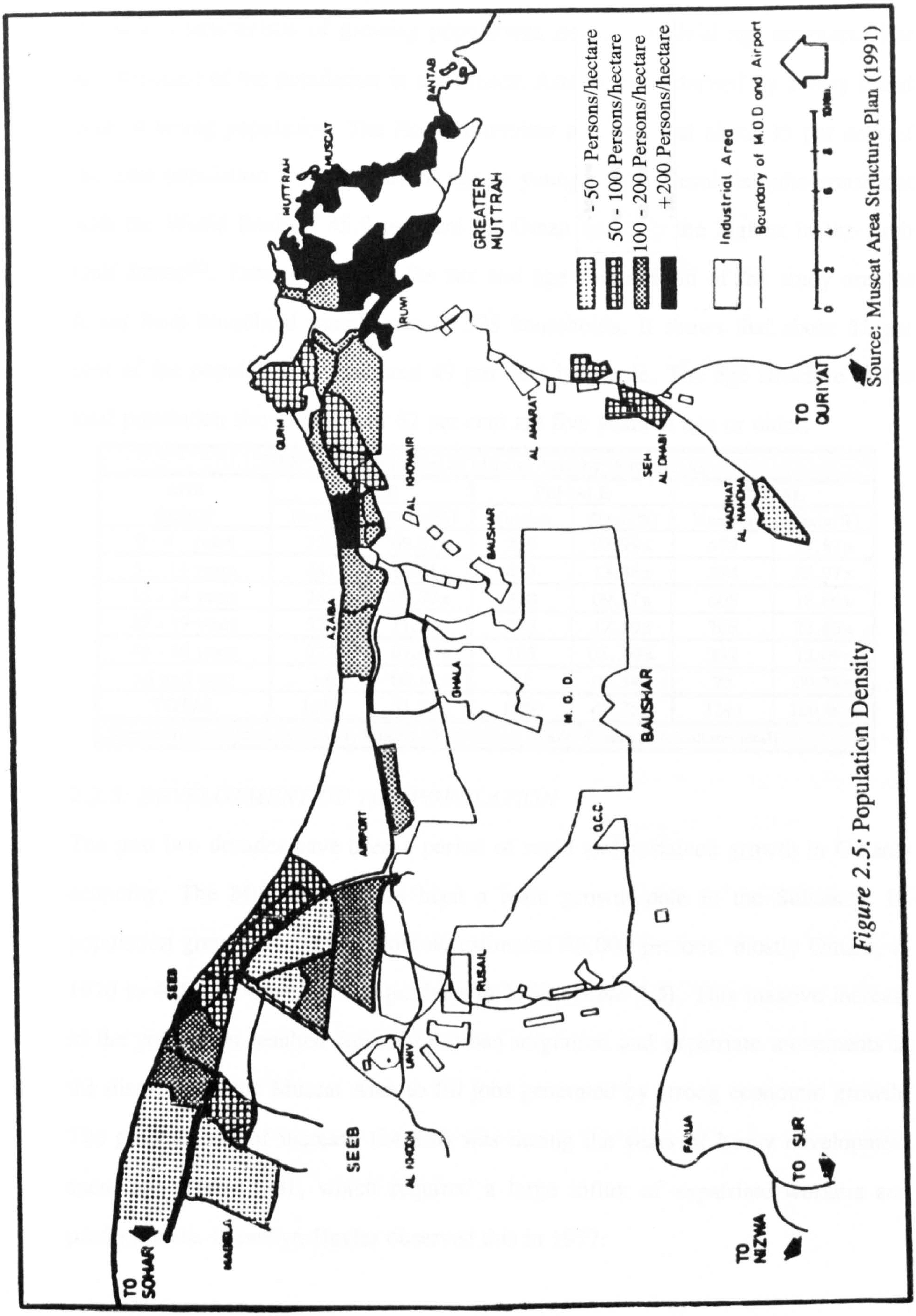



*Figure 2.5*: Population Density

Source: Muscat Area Structure Plan (1991)

## 2.2.4: *SEX AND AGE COMPOSITION*

A major characteristic of growing populations is their youthful age structure. The age structure of the population in the Muscat Area is characterised by a very broad base of young population. The Home Interview revealed that about 45 per cent of the total population was 14 years of age or younger. This result is quite consistent with the World Bank of 45.9 per cent for Oman which is the highest in the Arab Gulf States(8). *Table 2.4* shows the sex and age composition of the study area as found from household sample size of 528 households. It shows that about 51 per cent of the population is male and 49 per cent is female. The age structure of the total population shows that over 82 per cent are five years of age or older.

*Table 2.4* : Population of Muscat Area by Sex and Age

| AGE GROUP | MALE | | FEMALE | | TOTAL | |
|---|---|---|---|---|---|---|
| | Number | Share(%) | Number | Share(%) | Number | Share(%) |
| 0 - 4 years | 320 | 09.87% | 259 | 07.99% | 579 | 17.87% |
| 5 - 14 years | 441 | 13.61% | 433 | 13.36% | 874 | 26.97% |
| 15 - 24 years | 285 | 08.79% | 320 | 09.87% | 605 | 18.66% |
| 25 - 39 years | 374 | 11.54% | 392 | 12.10% | 766 | 23.63% |
| 40 - 65 years | 227 | 07.00% | 165 | 05..09% | 392 | 12.09% |
| 65 and over | 14 | 00.44% | 11 | 00.34% | 25 | 00.78% |
| TOTAL | 1661 | 51.25% | 1580 | 48.75% | 3241 | 100.00% |

Source: Home Interview Survey, Muscat 1990. ( Share % related to column total)

## 2.2.5: *DEVELOPMENT OF THE POPULATION*

The past two decades have been a period of rapid and sustained growth in Oman's economy. The Muscat Area has been a main growth pole in the Sultanate. Its population grew very rapidly from an estimated 25,000 persons, mostly Omani, in 1970 to 405 278 Omani and expatriates in 1989 (*Table 2.5*). This massive increase in the population resulted from rural-urban migration and expatriate movements in the direction of the Muscat Area to fill jobs generated by strong economic growth. The greatest rate of increase (24.8%) was during the years of heavy development spending 1978 - 1981, which required a large influx of expatriate workers and professionals. Llewelyn-Davies observed this in 1977:

> In common with many other Middle Eastern oil-producing countries, Oman has depended on a large intake of expatriates in order to implement the development programmes of the Sultanate.(9)

The huge increase in the Omani population was mainly due to rural-urban migration seeking better income and attaining a more desirable life style in the Muscat Area. In Oman, migrants are attracted from the rural areas to the Capital Area(10). Most of the migrants are often young men who come singly, as commuters, for government and private sectors, and then bring their families and set up a permanent home in the Muscat Area. The Middle East Economic Digest (1976) commented on rural migration:

> ... Indeed rural migration is the most severe problem facing the agricultural sector. A lot of young people are leaving the Interior and the Batinah coast for the Capital Area, where they are attracted by minimum wages of around O.R. 100 per month.(11)

The decline in the population growth between 1981 and 1984 from 24.8 per cent to 3.6 per cent cannot be justified (*table 2.5*). Particularly up to 1985 the economy in the Sultanate and especially in the Muscat Area was booming due to high oil prices and the execution of many major development projects. The most recent average annual growth rate (AAGR) of 9.6 per cent is considerably higher than the national growth rate (NGR) of 3.5 per cent recorded for the Sultanate of Oman(12).

The difference of 6.1 per cent could be attributed to rural-urban migration by the Omani population and the increase in the expatriate population. Weidleplan Consultant anticipated that the aggregate growth rate for the Muscat Area would be considerably lower, primarily due to a decrease in the rate of rural urban migration by the Omani population, while the NGR would continue at a very high level over the plan period. This is mainly due to greatly improved health and social services which have led to an increase in life expectancy.

| *Table 2.5* Muscat Area: Population Development and Growth | | | | | | | |
|---|---|---|---|---|---|---|---|
| Population Development | | | | Population Growth Rates | | | |
| Year | Omani | Non-Omani | Total | Average Annual Growth Rate | | | |
| 1970 | N.A. | N.A. | 025 000 | Period | Omani | Non-Omani | Total |
| 1974 | N.A. | N.A | 063 000 | 1970-1974 | N.A. | N.A. | 20.5% |
| 1977 | 080000 | 030000 | 110 000 | 1974-1977 | N.A. | N.A | 20.3% |
| 1981 | 120000 | 110000 | 230 000 | 1977-1981 | 9.61% | 27.3% | 24.8% |
| 1984 | 150000 | 105000 | 256 000 | 1981-1984 | 7.2 % | -1.6% | 3.6% |
| 1989 | 263000 | 142000 | 405 000 | 1984-1989 | 10.6% | 5.6% | 9.6% |
| 1995 | 333400 | 155900 | 489 300 | 1989-1995 | 4.2% | 1.6% | 3.2% |
| 2000 | 413600 | 166400 | 580 000 | 1995-2000 | 4.4% | 1.3% | 3.5% |
| 2005 | 468600 | 171400 | 640 000 | 2000-2005 | 4.5% | 0.6% | 3.5% |
| 2010 | 552500 | 177800 | 730 300 | 2005-2010 | 4.6% | 0.7% | 3.8% |
| Sources: (1) Oman Planning, Llewelyn- Davies, 1977. (2) Capital Area Structure Plan, Llewelyn - Davies, 1982 (3)Muscat Area Housing Study, Weidleplan, 1989 "Own calculation" | | | | | | | |

## 2.2.6: *DISTRIBUTION OF FUTURE POPULATION*

According to the final report of the Muscat Regional Plan (1991), the distribution of future population by urban areas was based on the supply of the facilities, utilities and land availability. *Table 2.6* and *Figure 2.6* Show the distribution of the population in the years 1989 and 2010. It is apparent that Muttrah will experience the lowest population growth in the planning period, with only 28,821 persons to be additionally accommodated there by the year 2010. This makes up nearly 9 per cent of the anticipated total additional population (324,722 ) of the Muscat Area by the year 2010, while Seeb will have the highest population growth. This anticipated increase of 220,345 persons will lead to the development of Seeb to be the secondary centre, due to its advantageous location (Gate to the other regions) and land availability.

| *Table 2.6* :Population Distribution in 1989 - 2010 | | | | |
|---|---|---|---|---|
| Municipality | 1989 Population | | 2010 Population | |
| | Number | Percentage | Number | Percentage |
| MUTTRAH | 156 179 | 39% | 185 000 | 25% |
| BOASHAR | 105 070 | 26% | 150 000 | 21% |
| SEEB | 109 655 | 27% | 330 000 | 45% |
| AL-AMARAT | 034 374 | 08% | 065 000 | 09% |
| MUSCAT AREA | 405 278 | 100% | 730 000 | 100% |
| Source: Muscat Area Regional Plan, Phase3, Report no.4 - Final Regional Plan Report. | | | | |

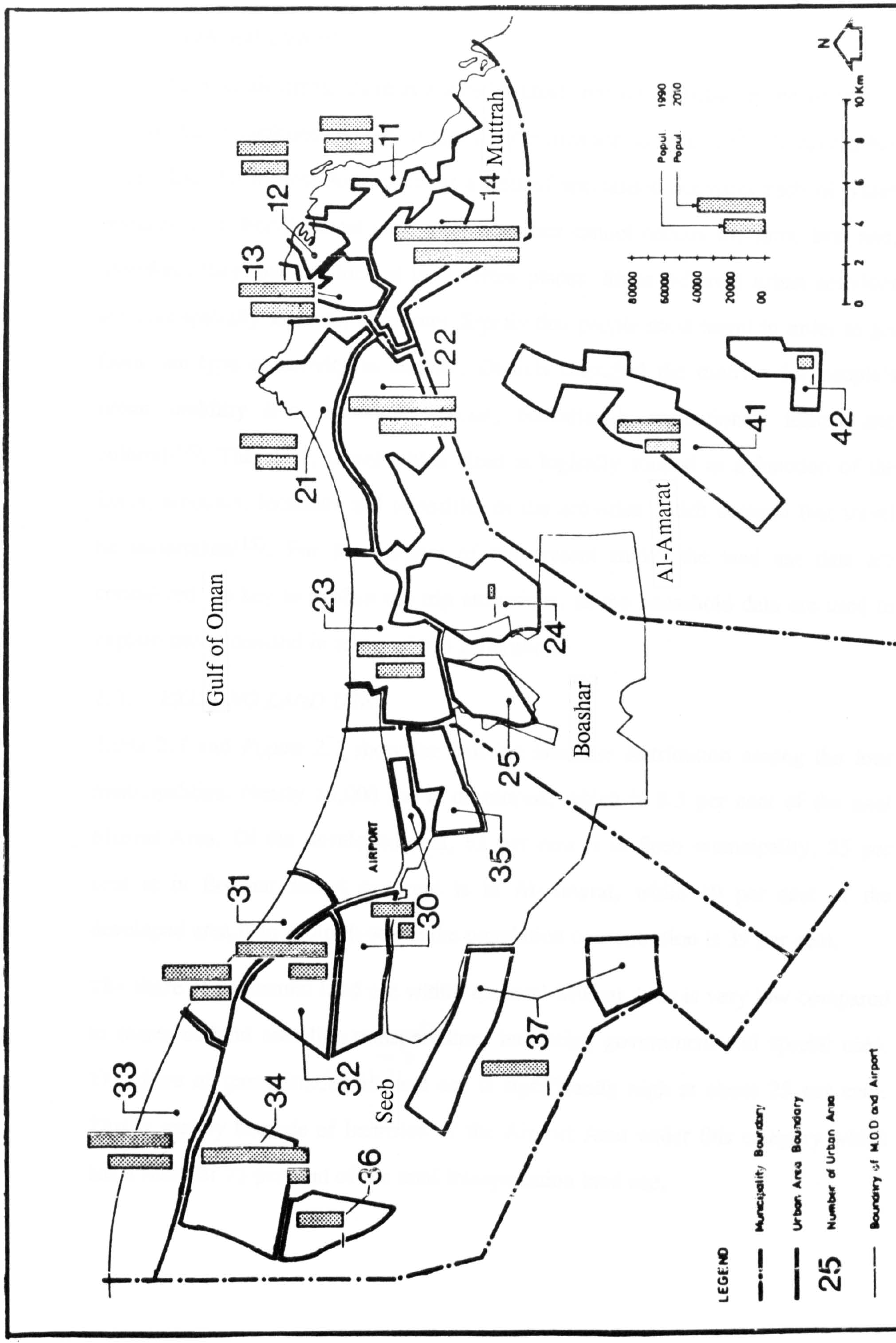



*Figure 2.6:* Urban Areas and Population Distribution 1990 and 2010

Source: Muscat Area Structure Plan (1991)

## 2.3: LAND USE

### 2.3.1: *INTRODUCTION*

In all cities at all times, there is a close mutual interaction between the pattern of transportation facilities and the pattern of activities and land uses(13). A large urban region like the Muscat Area contains a host of specialised activities each of which requires land. For the most part, these activities cannot occupy the same land and, therefore, they must be located in different places. Since different urban activities are thus spatially separate, it follows directly that people must travel in order to get from one type of activity to another. Daniels classified the motives for people's urban mobility into: economic; social; educational; recreational; leisure and cultural(14). Therefore, travel within cities is logically studied as a function of the kinds, amounts, locations and intensities of the activities which demand that travel be undertaken(15). For the purpose of the present study, the land use data are considered the key to explain the trip attractions, as the household data are used to explain travel demand in terms of trip generation.

### 2.3.2: *EXISTING LAND USE*

*Table* 2.7 and *Figure 2.7* show the existing land use distribution among the four municipalities. Nearly 15,000 ha. is developed, which is 6.5 per cent of the total Muscat Area. Of the developed area, 61 per cent is in Seeb municipality, 25 per cent is in Boashar and 4 per cent is in Al-Amarat, while 10 per cent of the developed area is in Muttrah where the population concentration is 39 per cent.

The share of residential land use within the total Muscat Area is very low compared to shares of land uses like transportation, industrial, government and special uses. The share of transportation in land use is significantly high at about 25 per cent. This is mainly because of inclusion of the Airport Area under this category which has a share of 73 per cent of the total transportation land use.

| *Table 2.7* : Land Use Distribution in 1990 ( Area in Hectares ) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Land Use Category | Muttrah | | Boashar | | Seeb | | Al-Amarat | | Muscat Area | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| Residential | 540 | 37.9% | 974 | 26.4% | 1736 | 18.9% | 281 | 47.7% | 3531 | 23.7% |
| Resid'l/Com'l | 179 | 12.6% | 22 | 00.6% | 42 | 00.5% | 1 | 00.2% | 244 | 01.7% |
| Commercial | 22 | 01.5% | 47 | 01.3% | 20 | 00.2% | 4 | 00.6% | 93 | 00.6% |
| Industrial | 178 | 12.5% | 1013 | 27.5% | 375 | 04.1% | 61 | 10.3% | 1627 | 10.9% |
| Facilities | 170 | 11.9% | 281 | 07.6% | 159 | 01.7% | 26 | 04.5% | 636 | 04.3% |
| Public Utilities | 38 | 02.7% | 63 | 01.7% | 30 | 00.3% | 10 | 01.7% | 141 | 01.0% |
| Transport | 192 | 13.5% | 240 | 06.5% | 3207* | 34.9% | 127 | 21.6% | 3766 | 25.3% |
| Special Use | 65 | 4.6% | 496 | 13.5% | 956 | 10.4% | 4 | 00.6% | 1521 | 10.2% |
| Governmental | 35 | 2.4% | 222 | 06.0% | 1379 | 15.0% | 6 | 01.1% | 1693 | 11.0% |
| Agriculture | 6 | 0.4% | 329 | 08.9% | 1289 | 14.0% | 69 | 11.7% | 1642 | 11.3% |
| **Total Developed** | **1425** | **100%** | **3687** | **100%** | **9193** | **100%** | **589** | **100%** | **14894** | **100%** |

Source: Muscat Area Structure Plan, Phase 1- Survey Report, November 1989.
Note: ( Share in % related to column total ) * Including the Airport area covering about 2800 ha.

The share of industrial land use is more than 10 per cent which may suggest a highly developed industrial sector but, actually, as the Weidleplan Consultant stated, this figure is misleading. This is because about 70 per cent of this land is used for warehousing activities and labour camps. So, the industrial sector in Muscat is in fact under-developed.

Being the capital of the country, it is obvious that the share of land under governmental or institutional use in Muscat will be significantly high but, a share of 11 per cent of the total land use is very high. This is mainly because of large pieces of land held by various administrations and institutions for their long term needs and/or strategic reasons. Share of agricultural land use is 11 per cent owing to the typical development characteristics and continuation of agriculture as an economic activity in some parts of the Muscat Area.

At the municipal level, nearly 50 per cent of the residential land is concentrated in Seeb where there is only 27 per cent of the population. On the other hand, Muttrah, with a residential share of 15 per cent accommodates nearly 39 per cent of the total population. Boashar has a share of 28 per cent of residential land, and 26 per cent of the total population. In Al-Amarat the figures are 8 per cent and 8 per cent.

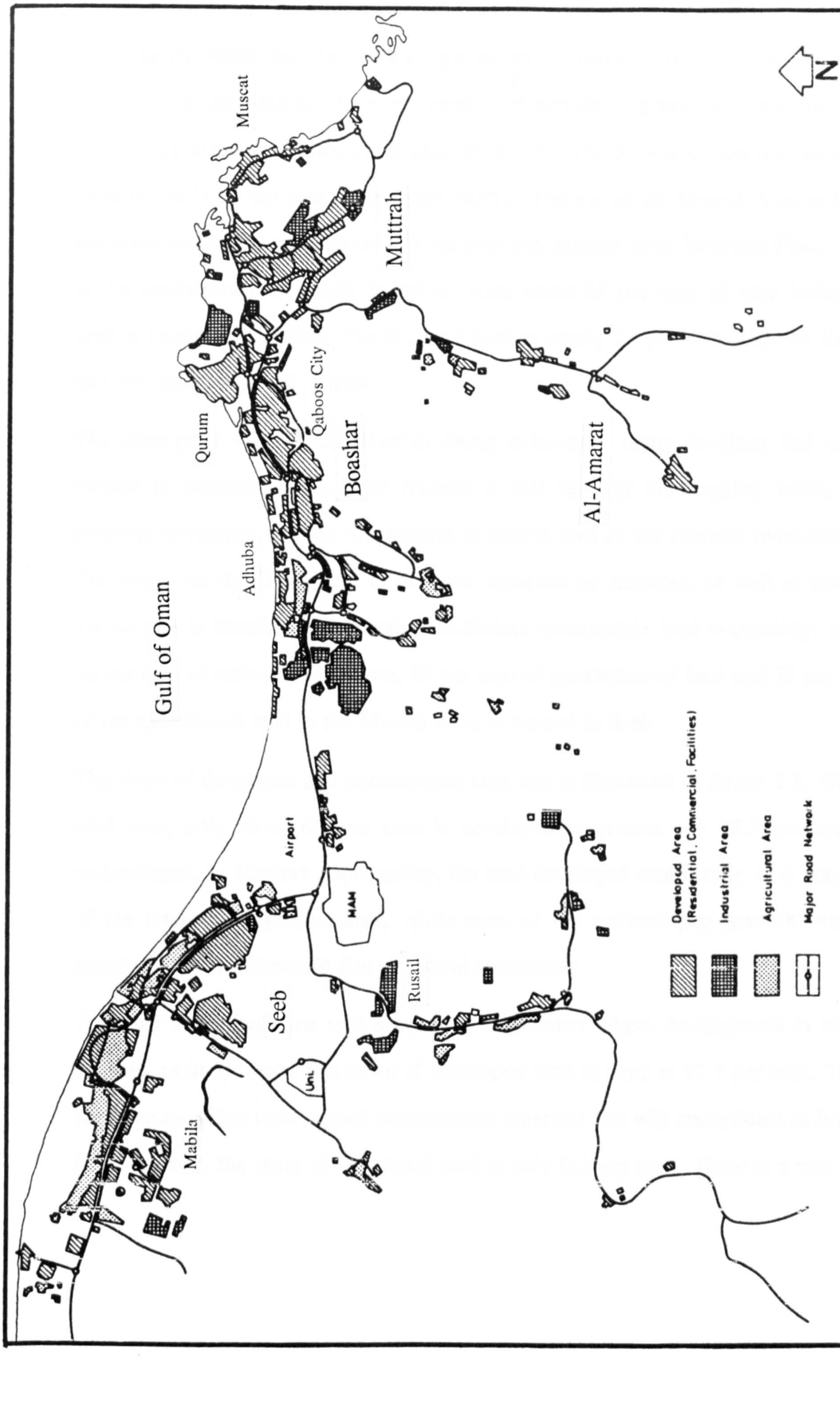



*Figure* 2.7: Major Land Use in 1990

Source: Muscat Area Structure Plan (1991)

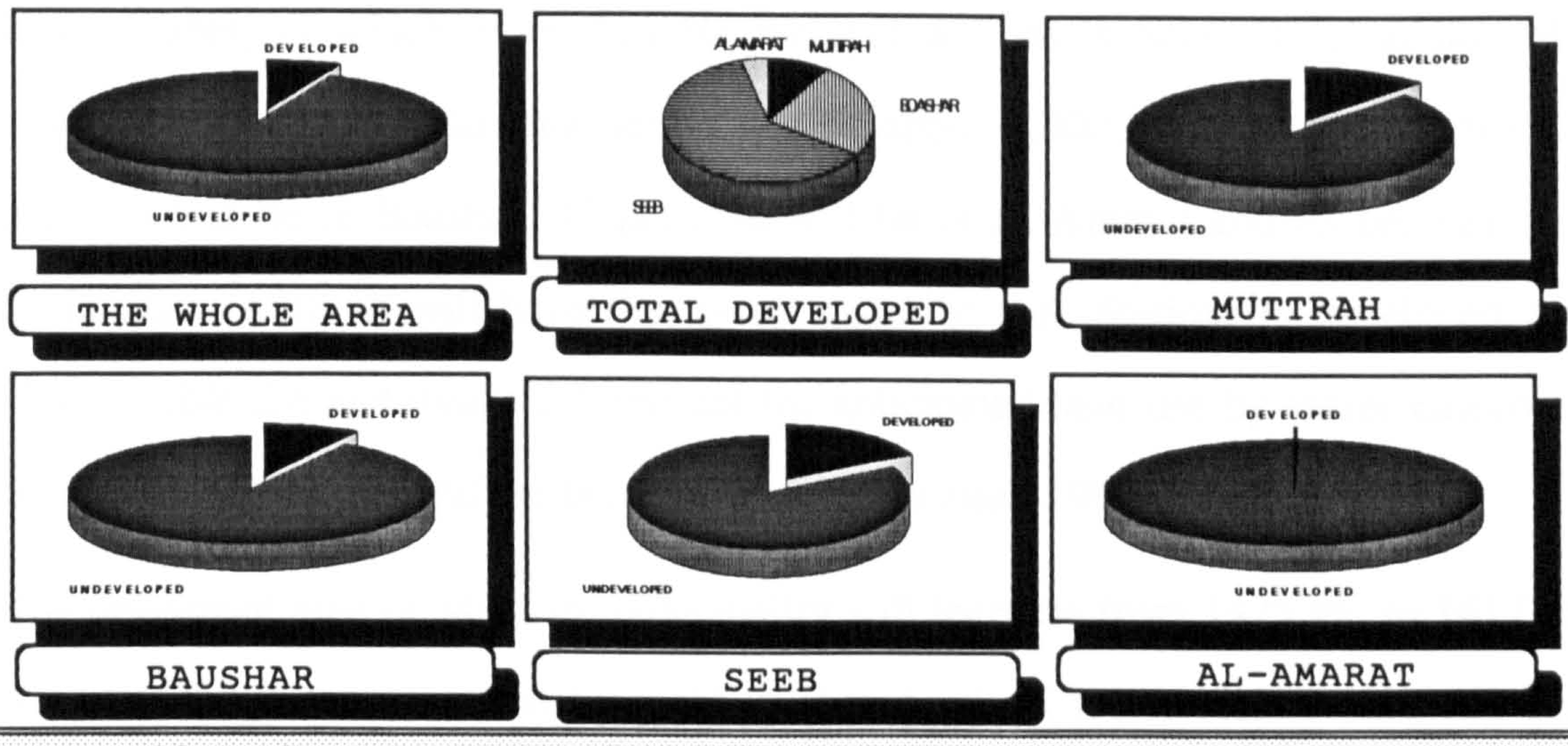
As much as 73 per cent of residential/commercial land use is located in Muttrah municipality which, together with a high population density, indicates the high level of centrality. In Boashar, the occurrence of mixed development is less as most of the housing areas are for the upper class of society. The Structure Plan indicates that there is nearly 50 per cent of total commercial land use in the Muscat Area as there are organised commercial centres by the previous Muscat Area Structure Plans. Due to the development of Ghala Industrial Area about 62 per cent of total industrial land is located in Boashar. The share of Seeb is nearly 23 per cent with the Rusail and Ma'abila Industrial Estates.

The absorptive capacity of Muttrah being exhausted, many facilities had to be located in Boashar. One of the reasons is that Boashar municipality which was properly developed was the first natural extension area of the Muttrah municipality. Therefore, nearly 45 per cent of the land occupied by facilities, as well as utilities are located in Boashar. As a result of sufficient developable land availability, about 50 per cent of residential land use, 84 per cent of governmental land and 75 per cent of the agricultural land in the Muscat Area is located in Seeb.

The share of developed and undeveloped land use is illustrated in *figure 2.8*. Of the total area, only about 6.5 per cent is developed at present and 93.5 per cent is undeveloped. In Muttrah municipality, the total developed area is only 12.6 per cent of the total administrative area, while most of the undeveloped land (87.4%) is unsuitable for development due to natural constraints.

The total developed area is 8.8 per cent in Boashar where development is not as compact as in Muttrah. The share of developed land in Seeb is 17.7 per cent. These two municipalities have a good development potential and will consolidate in future. In Al-Amarat, the share of developed land is only 0.5 per cent. There is a vast area available for development but due to limited accessibility, the present potential is low.

*Figure 2.8* : Share of developed areas in 1989




source: Muscat Structure Area Plan, Phase 1- Survey Report, November 1989. "Own calculation"

## 2.3.3: *FUTURE LAND USE*

Population estimates are the beginning point for estimating future land use; they indicate the magnitude of urban growth. As previously indicated, the Muscat Area has to provide residential capacities for 730,000 inhabitants by the end of the planning period against 417,000 in 1990. The distribution of additional population among the four municipalities will be guided by the availability of new areas and by the possibilities of densification in the developed areas. Therefore, the highest increase will take place in the Seeb municipality, while the development in Greater Muttrah will be consolidated.

The anticipated expansion of the residential areas in the Boashar municipality should take place in a way which allows the most effective use of infrastructure and facilities which provide land reserves for the population growth after 2010. Compared to its potential of developable land, the anticipated increase of Al-Amarat municipality will be moderate. The remaining land reserves are considerable for the urban development in the phase after the year 2010.

The Structure Plan indicates that the total developed area in 2010 will be about 22, 000 hectares, of which more than 60 per cent will be in Seeb. Total additionally developed area in the planning period will be about 7,300 hectares. Out of that, 20 per cent will be in Boashar, 15 per cent will be in Al-Amarat and 63 per cent will be in Seeb. Muttrah will have the lowest share of the additionally developed area (2%). *Table 2.8* and *figure 2.9* present the anticipated land use by major categories on municipality level and the land use growth between 1990 and 2010.

The developed area of Muttrah municipality will increase from 1425 ha. to 1617 ha. About 858 ha. are occupied by residential and mixed residential/commercial land use providing sufficient space for the anticipated population of 185,000 in 2010. The Consultant indicates that due to Muttrah municipality's role as a major service centre of the Muscat Area, the commercial land use will increase, but due to the already congested situation this growth will generally take place in mixed residential/ commercial land use (multi-storey building).

*Table 2.8* : Land Use Distribution in 1990 and 2010 ( Area in Hectares )

| Land Use Category | Muttrah | | Boashar | | Seeb | | Al-Amarat | | Muscat Area | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2010 | 1990 | 2010 | 1990 | 2010 | 1990 | 2010 | 1990 | 2010 |
| Residential | 540 | 615 | 974 | 1939 | 1736 | 5132 | 281 | 1082 | 3531 | 8768 |
| Resid'l/Comm'l | 179 | 243 | 22 | 51 | 42 | 90 | 1 | 29 | 244 | 413 |
| Commercial | 22 | 22 | 47 | 99 | 20 | 638 | 4 | 85 | 93 | 844 |
| Industrial | 178 | 192 | 1013 | 1355 | 375 | 782 | 61 | 99 | 1627 | 2428 |
| Facilities | 170 | 233 | 281 | 392 | 159 | 507 | 26 | 94 | 636 | 1226 |
| Public Utilities | 38 | 53 | 63 | 83 | 30 | 118 | 10 | 19 | 141 | 273 |
| Transport | 192 | 192 | 240 | 240 | 3207* | 3207 | 127 | 127 | 3766 | 3766 |
| Special Use | 65 | 25 | 496 | 496 | 956 | 956 | 4 | 4 | 1521 | 1481 |
| Governmental | 35 | 36 | 222 | 304 | 1379 | 1434 | 6 | 2 | 1693 | 1776 |
| Agriculture | 6 | 6 | 329 | 173 | 1289 | 957 | 69 | 80 | 1642 | 1216 |
| **Total Developed** | **1425** | **1617** | **3687** | **5132** | **9193** | **13821** | **589** | **1621** | **14894** | **22191** |

Source: Muscat Area Structure Plan, July 1991.
* Including the Airport area Covering about 2800 ha.

During the next 20 years, the anticipated population growth in Boashar is around 40 per cent, increasing the number of inhabitants from 108,000 to 150,000. In order to provide sufficient space for this expansion, some 965 ha. additional residential areas are proposed for development up to 2010, increasing the total residential land use to 1,939 ha. against 974 ha. in 1990. This area includes 156 ha. of agriculture land which is proposed for residential purposes. The industrial land use is dominant in the municipality and it will maintain its role in the future. The proposed expansion of industrial activities will be at Adheiba, this area makes up a buffer zone between the residential areas in the east and Seeb International Airport in the west. Due to the existing economic activities, this location provides the necessary advantages for the industrial expansion in the future. The overall growth of industrial land use in Boashar is around 32 per cent and cover an area of 1,335 ha. in 2010.

In Seeb municipality, the population is projected at 330,000, (i.e., an increase of about 200 %). The developed area will increase from 9,193 ha. at the present to 13,821 ha. in 2010. Gross residential area will increase from 1736 ha. to 5132 ha. in the year 2010. According to the development concept, Seeb will be the secondary centre by the end of the planning period. It will serve population in surrounding regions, besides its resident population, for various social, economical and administration needs. Therefore, 618 ha. of commercial land is reserved for the new Seeb Centre.

Al-Amarat municipality is the smallest and the least developed part of the Muscat Area. According to the selected strategy, moderate development will take place during the planning period. The anticipated population is 65,000 persons. More than 800 ha. of additional land for residential purposes will have to be developed. The growth of commercial (from 4 to 85 ha.), industrial ( from 61 to 99 ha.), and public facilities/utilities (from 36 to 113 ha.) is very high, considering the existing deficits.

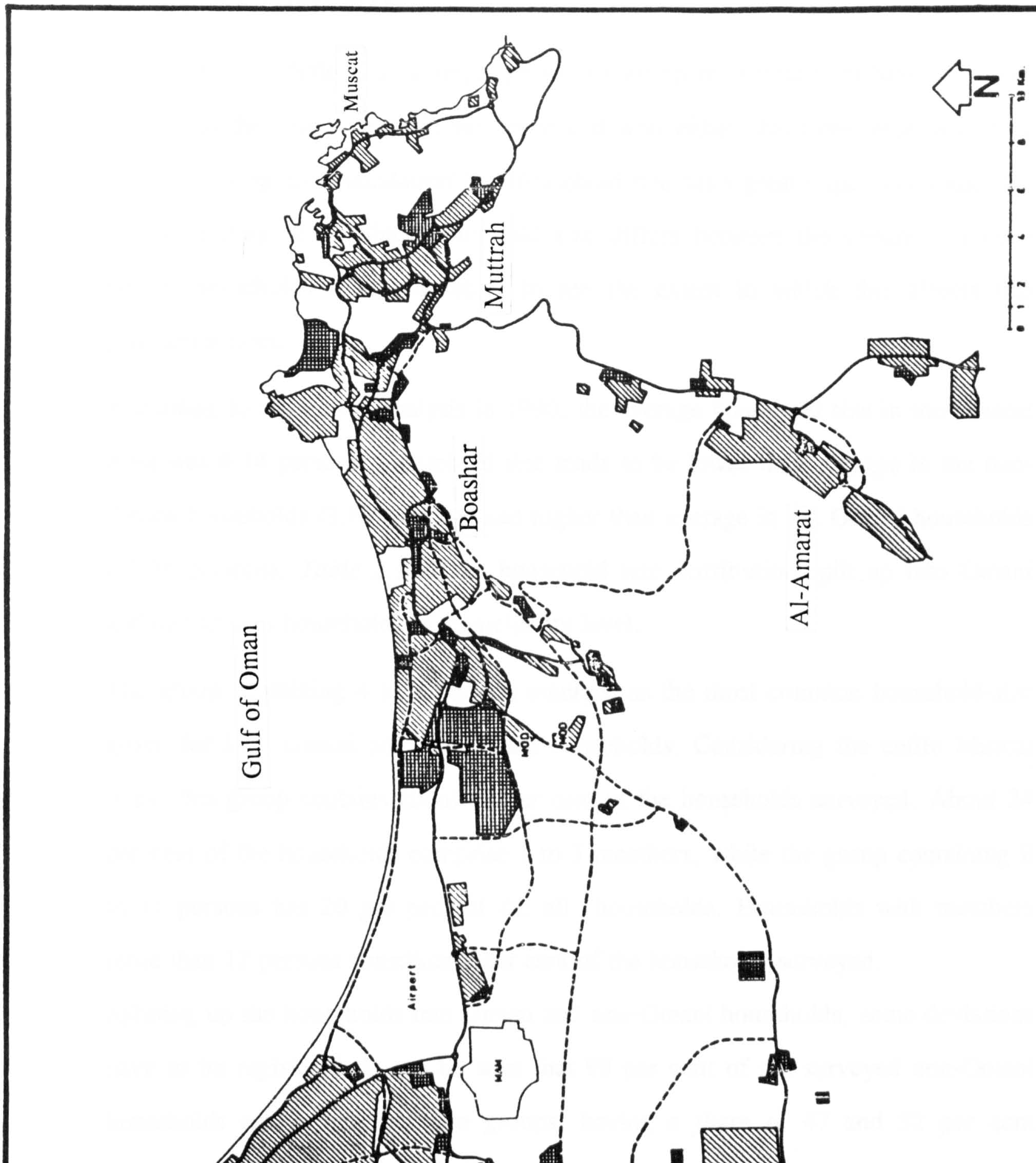



*Figure 2.9*: Major Land Use in 2010

Source: Muscat Area Structure Plan (1991)

## 2.4: HOUSEHOLD SIZE

A household is defined as a single person or group of people who have the same address as their only or main residence and who either share one meal a day or share the living accommodation[16]. Household size has a great impact on household trip generating rates. Since household size differs between the Omani and non-Omani households it is interesting to see the extent to which this affects trip generating rates.

According to the survey analysis in 1990, the average household size in the Muscat Area was 6.14 persons. Household size tends to be lower than average in the non-Omani households (3.65 persons) and higher than average in the Omani households ( 7.38 persons). *Table 2.9* shows household size distribution spilt up into Omani and non-Omani households at municipality level.

The group containing 4 to 7 persons emerges as the most common household-size group for both Omani and non-Omani households. Considering the entire Muscat Area, this group contains about 48 per cent of the households surveyed. About 24 per cent of the households comprise 1 to 3 members, while the group containing 8 to 11 persons has 20 per cent of the all households. Households with members more than 12 persons constitute 8 per cent of the households surveyed.

Splitting up the households into Omani and non-Omani households, some deviations have to be registered. It can be seen that 99 per cent of the surveyed non-Omani households are in the first two groups, having a share of 47 and 52 per cent respectively, while only 1 per cent of the non-Omani households have more than 8 persons. On the other hand, 46 per cent the Omani households are in the group containing 4 to 7 persons. The second highest share of households was recorded in 8 to 11 persons group (29 %), followed by 1 to 3 persons group (13 %). Omani households with members more than 12 persons account for 12 per cent of the Omani households surveyed.

| *Table 2.9* : Household Size by Nationality and Municipality | | | | | | | |
|---|---|---|---|---|---|---|---|
| Municipality | Nationality | Number of persons per household | | | | | |
| | | 1- 3 | 4 - 7 | 8 - 11 | 12 - 15 | more | TOTAL |
| MUTTRAH | Omani | 16% | 48% | 27% | 07% | 02% | 100% |
| | Non-Omani | 44% | 56% | 00% | 00% | 00% | 100% |
| | **Both** | **27%** | **51%** | **16%** | **05%** | **01%** | 100% |
| BOASHAR | Omani | 07% | 59% | 25% | 06% | 03% | 100% |
| | Non-Omani | 67% | 51% | 02% | 00% | 00% | 100% |
| | **Both** | **27%** | **55%** | **13%** | **3%** | **2%** | 100% |
| SEEB | Omani | 14% | 37% | 33% | 10% | 06% | 100% |
| | Non-Omani | 67% | 33% | 00% | 00% | 00% | 100% |
| | **Both** | **20%** | **36%** | **30%** | **09%** | **05%** | 100% |
| AL-AMARAT | Omani | 13% | 46% | 29% | 08% | 04% | 100% |
| | Non-Omani | 25% | 75% | 00% | 00% | 00% | 100% |
| | **Both** | **06%** | **49%** | **33%** | **09%** | **03%** | 100% |
| MUSCAT AREA | Omani | 13% | 46% | 29% | 08% | 04% | 100% |
| | Non-Omani | 47% | 52% | 01% | 00% | 00% | 100% |
| | **Both** | **24%** | **48%** | **20%** | **06%** | **02%** | 100% |

Source: Home Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to row total )
Note : household sample size: 528, where 352 Omani and 176 Non-Omani Households.

## 2.5: *HOUSEHOLD INCOME*

Household income affects both car ownership and the generation of travel(17). Residents interviewed in the Study Area were requested to indicate the appropriate range of their total monthly income from all sources. To simplify the analysis, household income was classified into low, medium, high and very high (*table 2.10*).

There is a significant variation in household income according to household location and nationality. In Boashar 63.2 per cent of the households belong to the high and very high income groups. This is consistent with the findings of the recent Muscat Area Housing Study for the same municipality and the same income groups (65%). The highest incomes were recorded in Qurum, Qaboos City and Information City where high income Omanis and expatriates are concentrated.

In Muttrah municipality about 60.87 per cent of the households are in the medium income group. The low income shares 11.31 per cent of the households and most of them are concentrated in the old towns of Sidab, Muscat and Muttrah. In Seeb, 66.42 per cent of the households are in the low or medium income groups, the lowest income being registered in Al Mawelah, Hail, Seeb and Ma'abila. About 78.79 per cent of the households in Al-Amarat are in the low or medium income groups, in which 18.18 per cent of the households have less than 200 Rail Omani per month at their disposal.

*Table 2.10*: Household Income by Nationality and Municipality. (Rail Omani)

| Municipality | Low Income Household | | Medium Income Household | | High Income Household | | Very high Inc. | Total |
|---|---|---|---|---|---|---|---|---|
| | <150 | 151-200 | 201-400 | 401-600 | 601-800 | 801-1000 | >1000 | (%) |
| Muttrah | 3.48% | 7.83% | 33.48% | 27.39% | 12.17% | 8.69% | 6.96% | 100% |
| Boashar | 0.80% | 3.00% | 17.2% | 15.80% | 16.80% | 19.2% | 27.2% | 100% |
| Seeb | 5.00% | 11.43% | 29.28% | 20.71% | 12.86% | 9.29% | 11.43% | 100% |
| Al-Amarat | 6.06% | 12.12% | 18.18% | 42.43% | 12.12% | 6.06% | 3.03% | 100% |
| Muscat Area | **3.41%** | **7.20%** | **27.08%** | **25.00%** | **13.45%** | **11.17%** | **12.69%** | **100%** |
| Omani | 4.55% | 8.52% | 23.86% | 25.00% | 13.92% | 11.36% | 12.79% | 100% |
| Non-Omani | 1.14% | 4.55% | 33.52% | 25.00% | 12.50% | 10.80% | 12.50% | 100% |

Source: Home Interview Survey, Fieldwork, Muscat 1990. ( Share in % related to row total)

Considering the Muscat Area as a whole, 76.7 per cent of the total households are in the intermediate income groups, 12.69 per cent of the households are in very high income, and only 10.61 per cent are in the lower income group.

The table shows that 58.52 per cent of the non-Omanis households are in the medium group, 23.3 per cent in the high group and 12.5 per cent in the very high group. The lower income group share only 5.69 per cent of the non-Omani households because the majority of the low income expatriates living in labour camp accommodation were not included in the sample. Most of the expatriates living in households earn medium and high salaries. A percentage of 13.07 of the Omani households are in the low income group, 12.79 per cent in the very high group and 74.14 per cent in the other groups.

Assuming that the household income is the main indicator of socio-economic status, there is a clear division between the different socio-economic groups in the Muscat Area. The low and medium- income groups are concentrated in Al-Amarat and large parts of Greater Muttrah and Seeb (such as Sidab, Muscat, Muttrah, Mawelah, Seeb and Ma'abila). The high income groups are mainly in the rest of Greater Muttrah and Seeb parts of Boashar. The very high income groups are concentrated in Boashar and in certain areas in Seeb and Greater Muttrah.

## 2.6 : EMPLOYMENT

### 2.6.1: *EMPLOYMENT DISTRIBUTION*

The geographical distribution of employment was considered to be the best guide-line to explain traffic characteristics in terms of trip attraction. Reliable data showing the distribution of employment in the Muscat Area for small statistical areas or even among the municipalities are not available. Conducting an Employment Survey was beyond the means of the researcher. Therefore, relative information is used to indicate the distribution of employment in the Muscat Area. Thus, reviewing land use distribution together with distribution of units occupied by commercial activities and sectoral distribution of jobs might give a good indication of the trip attraction areas, (the land use distribution is described in detail in section 2.3.). The distribution of units occupied by commercial activities (Commercial Units) among the municipalities are shown in *Table 2.11*.

*Table 2.11* :Distribution of commercial and residential units by municipality

| Type of unit | Muttrah | | Boashar | | Seeb | | Al-Amarat | | Muscat Area | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| Villa | 2060 | 8% | 4524 | 35% | 3376 | 27% | 709 | 16% | 10669 | 18% |
| Arabic House | 7348 | 27% | 1296 | 10% | 4336 | 36% | 2224 | 51% | 15204 | 27% |
| Flat | 8977 | 33% | 3136 | 25% | 851 | 7% | 119 | 3% | 13083 | 23% |
| **Comm'l Units** | **7148** | **27%** | **1716** | **13%** | **2317** | **18%** | **631** | **14%** | **11812** | **21%** |
| Others | 1304 | 5% | 2188 | 17% | 1485 | 12% | 715 | 16% | 5692 | 10% |
| Total No of unit | 26837 | 100% | 12860 | 100% | 12365 | 100% | 4398 | 100% | 56460 | 100% |

Source: Unpublished survey results conducted by the Development Council between June & September 1989. Note: ( Share in % related to column total ) - Own calculation -

The commercial units share nearly 21 per cent of the total units in the Muscat Area. From the total number of the establishment units, Muttrah has 61 per cent, Boashar 14 per cent, Seeb 20 per cent and Al-Amarat 5 per cent, reflecting the concentration of retailing and other related businesses in Muttrah municipality.

Comprehensive statistics on sectoral distribution of jobs are not available. The sectoral distribution of jobs was estimated by Weidleplan Consultant in the 1989 Muscat Area Housing Study. The estimate was based on different sources of information like Socio-Demographic Survey by the Development Council in 1985 and Statistical Year books.

*Table 2.12* shows the sectoral distribution of jobs and the anticipated future development of sectoral share of jobs. The public administration sector had the highest share of sectoral jobs in 1990. The Consultants' assessment of the future development of job opportunities was based on plausible assumption on the future development of the different sectors. The total number of jobs will increase from about 174,000 in 1990 to 285,000 in 2010, and the share of Omani labour is expected to increase from 36 per cent to 50 per cent for the same period.

*Table 2.12*: Job Distribution and development in the Muscat Area

| Sectoral distribution of jobs in the Muscat Area 1990 | | | | | | | Development of Sectoral jobs | |
|---|---|---|---|---|---|---|---|---|
| SECTOR | | Total Employed | | <Share of Labour> | | | | |
| | Sub-Sector | No. | Share | Omani | Others | (%) | 2000 | 2010 |
| PRIMARY | Agriculture | 3478 | 2.0% | 55% | 45% | 100% | 8.6% | 8.9% |
| | Fisheries | 6955 | 4.0% | 55% | 45% | 100% | | |
| | Mini. & Quarrying | 4347 | 2.5% | 60% | 40% | 100% | | |
| SECONDARY | Manufacturing | 13041 | 7.5% | 10% | 90% | 100% | 20.2% | 21.3% |
| | Water & Electricity | 2608 | 1.5% | 40% | 60% | 100% | | |
| | Construction | 18258 | 10.5% | 5% | 95% | 100% | | |
| TERTIARY | Transp. & Commu. | 12172 | 7.0% | 55% | 45% | 100% | 69.0*% | 67.8#% |
| | Commerce | 27821 | 16.0% | 20% | 80% | 100% | | |
| | Catering | 6086 | 3.5% | 5% | 95% | 100% | | |
| | Other serv.(Private) | 26952 | 15.5% | 20% | 80% | 100% | | |
| | Pub Administration | 46079 | 26.5% | 60% | 40% | 100% | | |
| OTHERS | Undefined | 3478 | 2.0% | 80% | 20% | 100% | 2.2% | 2.0% |
| | Under-/ Unempl't | 2608 | 1.5% | 98% | 2% | 100% | | |
| Total | | 173884 | 100% | 36% | 64% | 100% | 100% | 100% |

Source: Muscat Area Housing Study(1990), Weidleplan-Muamir, Phase II, P 16&18.
Note: * Private sector share 40.2 % and Governmental 28.8% . # The share 40.9% to 26.9%.

Apparently the tertiary sector is the dominating sector during the planning period. The share of the secondary sector, especially the construction sector, is anticipated to increase, due to the population growth which will induce an increasing demand for residential building construction related facilities.

## 2.6.2: HOUSEHOLD AND EMPLOYMENT STATUS

As stated by many transport studies, the amount and mode of personal travel is influenced by the characteristics of the household generating the travel. Among these, are the number of employees per household and individual traveller's status as a student, employed or unemployed. Members of the households over five years old were asked to state their status. The number of employees per household and household members' occupational status, and the number of those who were working or schooling in the same area (traffic zone) where they lived are discussed in the following sections.

### 2.6.2.1: *NUMBER OF EMPLOYEES PER HOUSEHOLD*

Within the total households surveyed, only one household in the Seeb municipality had no employees. Students were classified as employees, therefore, the total number of employees per household means number of employed persons plus students. To simplify the analysis, the employees per household were grouped into four categories according to their number, (*Table 2.13*).

About 38.1 per cent of Muscat's households have 1-2 employees, 27.5 per cent have 3-4 employees, 21 per cent have 5-6 employees and 13.4 per cent have more than six employees. The variation in the number of employees per household at the municipal level reflects the household sizes in each municipality. The proportions in the number of Omani employees per household in each category do not vary significantly as in the non-Omani households, where about 61 per cent of the households have 1-2 employees.

| *Table 2.13* : Number of employed people per household by municipality | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1-2 Employed | | 3-4 Employed | | 5- 6Employed | | >6 Employed | | Total |
| Municipality | Number | (%) | Number | (%) | Number | (%) | Number | (%) | (%) |
| Muttrah | 93 | 40% | 68 | 30% | 44 | 19% | 25 | 11% | 100% |
| Boashar | 54 | 43% | 35 | 28% | 25 | 20% | 11 | 9% | 100% |
| Seeb | 45 | 32% | 33 | 24% | 36 | 26% | 26 | 18% | 100% |
| Al-Amarat | 9 | 27% | 9 | 27% | 7 | 21% | 8 | 24% | 100% |
| **Muscat Area** | **201** | **38%** | **145** | **28%** | **112** | **21%** | **70** | **13%** | 100% |
| Omani | 94 | 27% | 92 | 26% | 97 | 27% | 69 | 20% | 100% |
| non-Omani | 107 | 61% | 53 | 30% | 15 | 8% | 1 | 1% | 100% |
| Source: Home Interview Survey, Fieldwork Muscat, 1990.(Share in % related to row total) | | | | | | | | | |

## 2.6.2.2: HOUSEHOLD MEMBERS OCCUPATIONAL STATUS

About 76 per cent of the total persons over five years old in the households surveyed are employed and 24 per cent are unemployed. Out of the 24 per cent, 94 per cent are females and 6 per cent males. This high proportion of unemployed females reflects the cultural traditions of the society. The religious and cultural traditions of the Omani society give men the responsibility of supporting their wives, daughters and mothers. Furthermore, women are not obliged to meet the cost of their food, clothing and other necessities. Women in Islam are not obliged to contribute to these costs from their income whether they work or not. Another reason for the low proportion of unemployed females is that the majority of men are able to provide a desirable life style for their family without the need to get a support from any female member.

Students account for 55 per cent of the total employed ( 39% of the total persons) which supports the high proportion of youngsters, as seen in section 2.2.4. Female students account for 70 per cent of the total employed females and male students account for 42 per cent of total employed males. Excluding students, about 55 per cent of the total employed work with the government, 37 per cent work in the private sector and 8 per cent are self employed. The high proportion of government employees is a result of the concentration of government administrations and public services in the Muscat Area. As previously indicated (Chapter 1) and remarked by

Cowi Consult in the A'Dhahira Regional Plan (1990), despite the distance of more than 300 km. :

> " Very little scope for discretion is given to existing ministry offices in A'Dhahira, and many routine activities that could best be carried out at local level are undertaken at Muscat. It is common for citizens with problems or grievances regarding a government matter to go to Muscat to resolve it." (18)

*Table 2.14* shows the number of males and females under each of the five employment classes including the unemployed class. Generally, there is no significant variation in the employment classes from one municipality to another. In fact, they all have the same order in class share, starting with a high proportion of students then unemployed (mainly females), government, private, and ending with the low proportion of self employed.

*Table 2.14* : Males and Females under Various Employment Classes

| Municipality | Employment Class | *Student* | | *Government* | | *Privately* | | *Selfemplod* | | *Unemployed* | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sex ----> | **M** | **F** | **M** | **F** | **M** | **F** | **M** | **F** | **M** | **F** |
| **Muttrah** | Total persons | 205 | 207 | 179 | 40 | 127 | 43 | 32 | --- | 7 | 245 |
| | Share in sex total | 37% | 39% | 33% | 7% | 23% | 8% | 6% | --- | 1% | 46% |
| | Share per Class | <-38% > | | <-20 %-> | | <-16%-> | | <-3% -> | | <-23%-> | |
| **Boashar** | Total persons | 108 | 102 | 96 | 18 | 68 | 49 | 7 | --- | 5 | 121 |
| | Share in sex total | 38% | 35% | 34% | 6% | 24% | 17% | 2% | --- | 2% | 42% |
| | Share per Class | <-37% > | | < 20%-> | | < 20%-> | | < 1%-> | | < 22%-> | |
| **Seeb** | Total persons | 185 | 160 | 155 | 20 | 35 | 31 | 30 | 3 | 20 | 192 |
| | Share in sex total | 44% | 39% | 36% | 5% | 8% | 8% | 7% | 1% | 5% | 47% |
| | Share per Class | <-42%-> | | <-21%-> | | <-8 %-> | | <-4%-> | | <-25%-> | |
| **Al-Amarat** | Total persons | 53 | 44 | 32 | 8 | 9 | 9 | 1 | --- | 4 | 42 |
| | Share in sex total | 54% | 43% | 32% | 8% | 9% | 9% | 1% | -- | 4% | 41% |
| | Share per Class | <-48%-> | | <-20%-> | | < 9%-> | | <0.4 %> | | <-23%-> | |
| **Total Muscat Area** | **Total persons** | **551** | **513** | **462** | **86** | **239** | **132** | **70** | **3** | **36** | **600** |
| | **Share in sex total** | **40%** | **38%** | **34%** | **6%** | **18%** | **10%** | **5%** | **0%** | **3%** | **45%** |
| | **Share per Class** | **< 39%>** | | **< 20%->** | | **< 14%->** | | **< 3%->** | | **< 24%->** | |

Source: Home Interview Survey, Fieldwork Muscat, 1990. (Share in % related to row total)

### 2.6.2.3: HOUSEHOLD EMPLOYEES AND WORK PLACE

Work place has a great impact on mode of travel used, especially choosing between walking or travelling by a vehicle. *Table 2.15* shows the distribution of people working or schooling in the traffic zone where they live, their shares relative to total working or schooling persons per traffic zone. Females have the highest proportion in all the traffic zones with the exception of four traffic zones in Boashar. The high proportion of females is due the high share of female students out of the total employed (70% female & 42% male), in addition to high proportion of females working in the field of education. The effect of students on the high share of each zone's internal employees emerges from the good distribution of schools mostly among the traffic zones(19). It can also be seen that the variation from one zone to another fits properly with the concentration of jobs in that zone.

*Table 2.15*: Distribution of people working /schooling in the same traffic zone

| Traffic Zones | MALE | | FEMALE | | Traffic Zones | MALE | | FEMALE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Share* | No. | Share* | | No. | Share* | No. | Share* |
| **Muttrah Municipality** | | | | | **13** | 7 | 28.0% | 1 | 12.8% |
| **1** | 5 | 11.9% | 9 | 75.0% | **14** | 5 | 50.0% | 1 | 33.3% |
| **2** | 22 | 35.5% | 24 | 60.0% | **Seeb Municipality** | | | | |
| **3** | 41 | 45.1% | 22 | 53.7% | **15** | 2 | 20.0% | 0 | 0% |
| **4** | 67 | 39.0% | 46 | 50.5% | **16** | 1 | 4.3% | 1 | 16.3% |
| **5** | 36 | 28.3% | 33 | 38.4% | **17** | 13 | 18.8% | 9 | 28.1% |
| **6** | 15 | 37.5% | 10 | 50.0% | **18** | 20 | 29.9% | 31 | 51.7% |
| **Boashar Municipality** | | | | | **19** | 46 | 48.4% | 33 | 56.9% |
| **7** | 4 | 11.8% | 4 | 16.7% | **20** | 2 | 3.3% | 1 | 3.7% |
| **8** | 20 | 42.2% | 12 | 40.0% | **21** | 2 | 4.6% | 4 | 17.4% |
| **9** | 12 | 27.3% | 11 | 37.9% | **22** | 7 | 100% | 0 | 0% |
| **10** | 0 | 0% | 2 | 40.0% | **Al-Amarat Municipality** | | | | |
| **11** | 38 | 43.2% | 26 | 45.6% | **24** | 11 | 37.9% | 15 | 75.0% |
| **12** | 3 | 18.8% | 7 | 53.8% | **25** | 23 | 36.5% | 23 | 56.1% |

Source: Home Interview Survey, Fieldwork Muscat, 1990. (Zones Codes see Appendix A)
Note: Share* in % related to total employed of males or females per traffic zone

## 2.7: CAR AVAILABILITY

### 2.7.1: GENERAL

Car availability is perhaps the most important factor in the analysis of traffic generation characteristics and model selection. Many transport studies(15,17) show that the number of vehicles available to a household affects to a large extent the number of trips made and the mode of travel chosen by members of the household. The term car "availability", rather than "ownership", is used to allow for employers cars and other vehicle types used for personal transport, and this is expressed in terms of the number of cars per household.

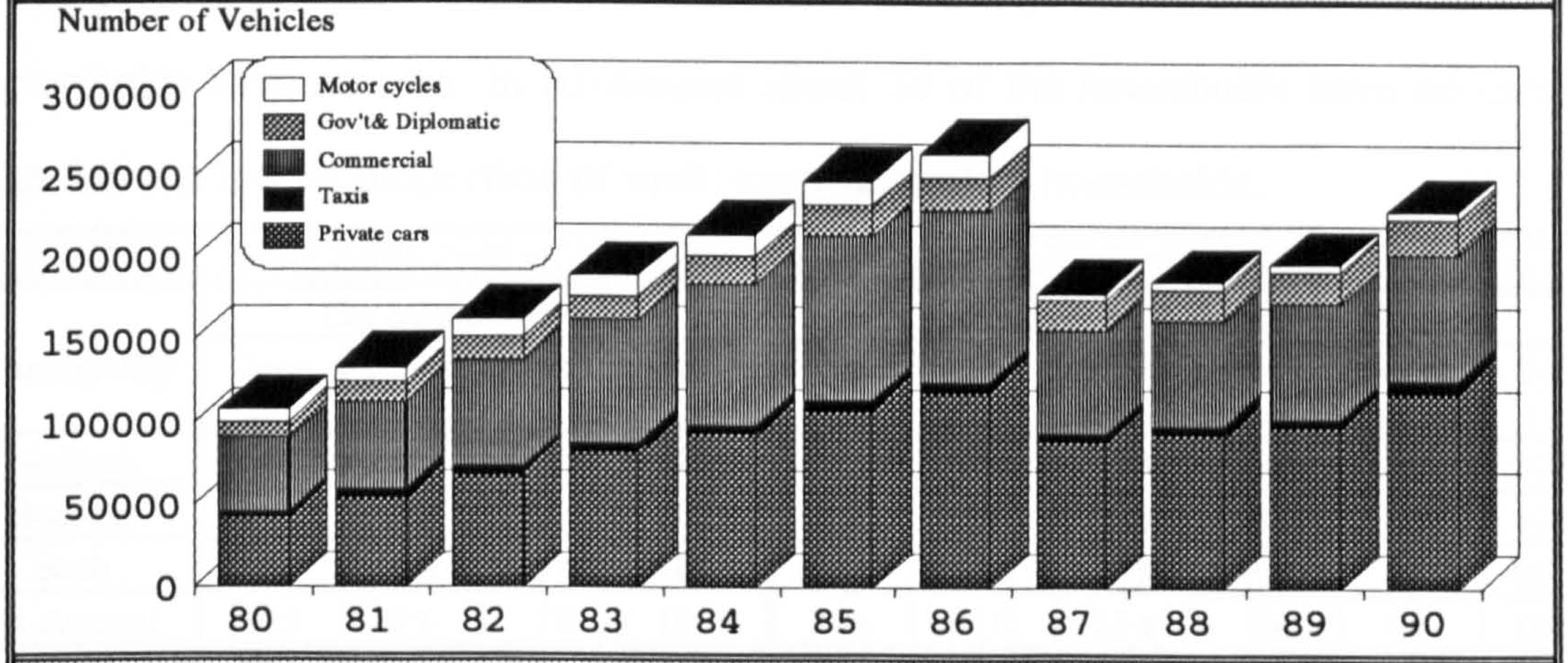
2.7.2: REGISTRATION TRENDS

Precise historical registration data for cars in the Muscat Area alone are not available as records are maintained only for the entire country. The past growth of the number of vehicles in Oman was obtained from vehicle registration data supplied by the Royal Oman Police Motor Vehicle Registry. *Figure 2.10,* shows that the total number of vehicles registered in the country decreased between 1986 and 1987. This sharp decline in the number of registered vehicles (85,922 vehicles) was due to the introduction of a new method of vehicle registration in which only the actual number of vehicles on the roads have to be considered. Therefore, the figures from 1987 onwards represent the actual number of vehicles on the roads each year, i.e., cancellations of vehicle licences were taken into account.

Despite the differences in the registration methods, in 1990 there were 2.13 times as many vehicles registered in Oman as in 1980. This represents an average annual growth of 13 per cent for all vehicles and 15 per cent for private cars. The vehicle fleet slowed down up to 1987 and then slightly increased up to the recent growth rate of 16.5 per cent for all vehicles and 20 per cent for private cars. These are very high growth rates, reflecting the set-up of the high economic growth of the Sultanate after the downturn in oil prices in 1985 and the recession that followed it. It seems that these growth rates will continue in future, particularly, very large increases in car ownership are expected during the next 20 years(20).

A total number of 106,253 vehicles were registered in the Muscat Area in 1990 and this accounts for about 50 per cent of the total vehicles registered in the whole country. This figure does not represent the actual number of vehicles in the Muscat Area because the current registration method does not consider the living address of the vehicle owner as an indicator of the region where the vehicle has to be registered. Thus, many vehicles in the Muscat Area have other regions' registration plates, while their owners are permanent residents of the Muscat Area. Therefore, for this study, data relating to car availability to person or household in the Muscat Area had to be calculated from the Home Interview.

*Figure 2.10*: Growth in vehicle fleet in the Sultanate of Oman from 1980 to 1990




Vehicle fleet in the Sultanate of Oman year to year growth rates

| Year | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Growth rates | ----- | 23.8 | 21.5 | 16.6 | 13.5 | 15.3 | 7.1 | ----- | 4.1 | 5.8 | 16.5 |

Source: Directorate General of Traffic Yearly Statistical Books, 85, 86, 87, 88, 89 &1990. Note: Vehicles of defence services are not included. ( Own calculation)

## 2.7.3: HOUSEHOLD CAR AVAILABILITY

In the Muscat Area, 81.4 per cent of the households have a car available, of which 69.8 per cent have one car and 30.2 per cent have two or more cars. Of the total number of households surveyed, 18.6 per cent have no car. Thus car availability is higher compared with the findings of the recent Capital Area Transport Study(1985) which indicated that 72.4 per cent of the households in the Muscat Area had a car available. Of the 72.4 per cent; 63.8 percent have one car and 36.2 per cent have two or more cars. The high proportion of car availability is due to high household income, the expansion of the Muscat Area, the lack of internal waterway and fixed track systems, and the unreliability of existing public transport.

*Table 2.16* shows the differences in household car availability according to municipality and household nationality. In Boashar Municipality, households have the highest proportion of car and multi-car availability. Thus, it can be said that 99 per cent of the households have a car available, confirming the high income households of this municipality. In Greater Muttrah, the area of high population density tends to be the area of lowest car availability. In Seeb 20 per cent of the households have no cars. In Al-Amarat about 24 of the households have no cars; it also has the lowest proportion of multi-car availability households.

*Table 2.16*: Type of car availability and their number per household

| Municipality | Car availability type | | | | Percentage of households having: | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Own car | Government | Company | Total (%) | No Cars | One Car | Two Cars | Three Cars | More than 3 | Total (%) |
| Muttrah | 84% | 4% | 11% | 100% | 27% | 52% | 13% | 4% | 4% | 100% |
| Boashar | 81% | 8% | 11% | 100% | 1% | 58% | 24% | 11% | 6% | 100% |
| Seeb | 93% | 6% | 1% | 100% | 20% | 56% | 17% | 6% | 1% | 100% |
| Al-Amarat | 90% | 3% | 7% | 100% | 24% | 61% | 15% | 0% | 0% | 100% |
| Muscat Area | **86%** | **6%** | **8%** | **100%** | **18%** | **57%** | **17%** | **4%** | **4%** | **100%** |
| Omani | 90% | 7% | 2% | 100% | 18% | 49% | 19% | 9% | 5% | 100% |
| non-Omani | 81% | 4% | 15% | 100% | 19% | 68% | 12% | 1% | 0% | 100% |

Source: Home Interview Survey, Fieldwork, Muscat 1990. ( Share in % related to row total)

Omani households have higher multi-car availability than non-Omani households. It can be noted from the table that 18.77 per cent of cars available for non-Omani households are owned by their employers. Thus, 67.61 per cent of non-Oman households have one car available, while 48.86 per cent of Omani households have one car available.

Data relating to the cars available per person and per household based on the results of the survey in 1990 are shown in *Table 2.17*. A total of 3241 persons living in the households surveyed have 650 cars available, representing 0.2 car per person and 1.23 cars per household. Considering Omani and non-Omani population some variation in car availability ratios can be observed. Omani households have higher car availability per household than non-Omani households. The number of cars per person is higher in the non-Omani population, reflecting the low proportion of population per household.

*Table 2.17*: Car Availability Rates per Person and Household

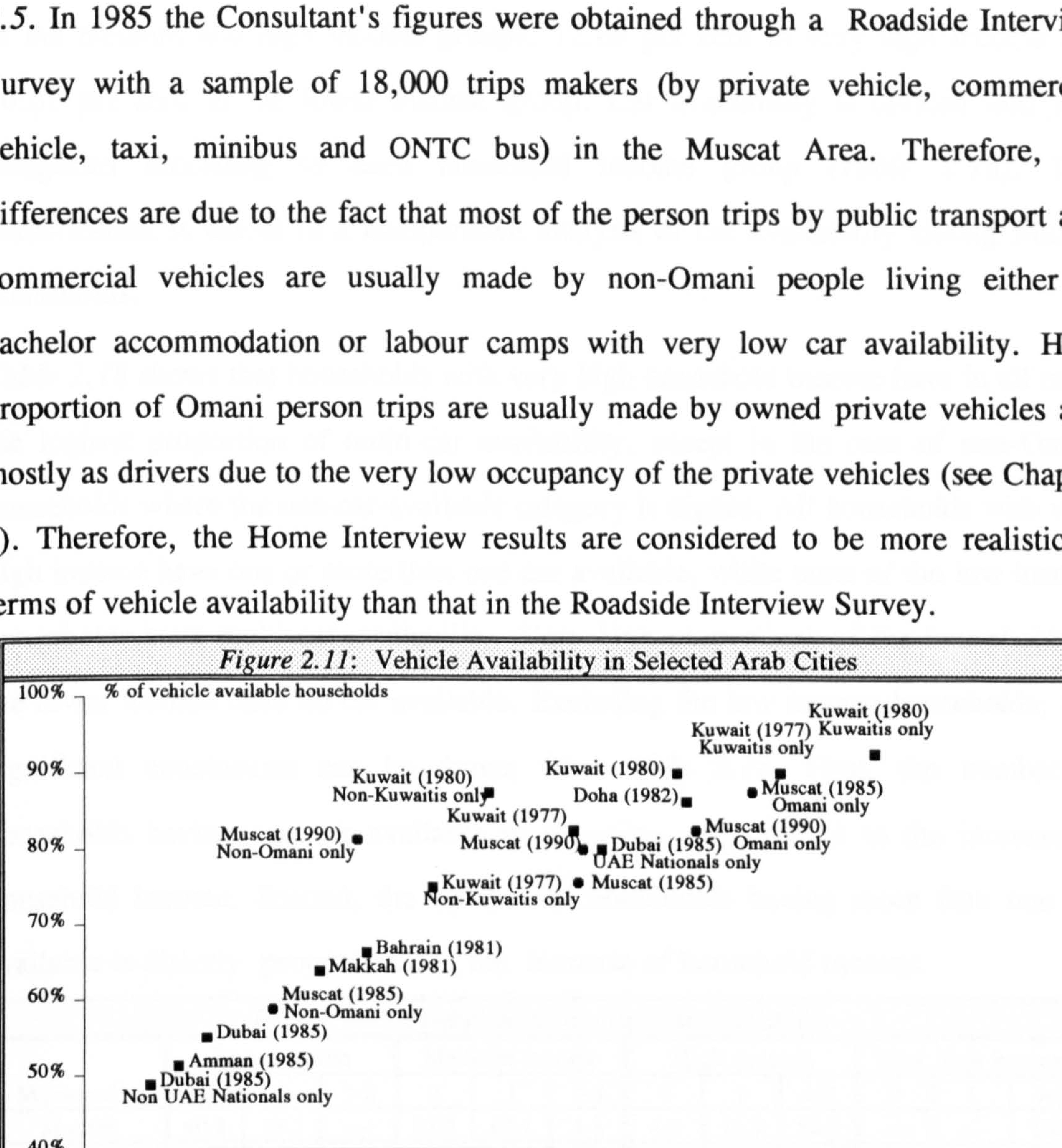
| Municipality | Population in households | Number Of Households | Population/ household | Number of Cars | Car per person | Car per household |
|---|---|---|---|---|---|---|
| Muttrah | 1288 | 230 | 5.6 | 250 | 0.19 | 1.10 |
| Boashar | 679 | 125 | 5.4 | 211 | 0.31 | 1.69 |
| Seeb | 1025 | 140 | 7.3 | 159 | 0.16 | 1.14 |
| Al-Amarat | 249 | 33 | 7.55 | 30 | 0.12 | 0.91 |
| Muscat Area | **3241** | **528** | **6.14** | **650** | **0.20** | **1.23** |
| Omani | 2599 | 352 | 7.38 | 484 | 0.19 | 1.38 |
| Non-Omani | 642 | 176 | 3.65 | 166 | 0.26 | 0.94 |

Source: Home Interview Survey, Fieldwork, Muscat 1990.

A comparison of the Muscat Area vehicle availability statistics with data from other Middle East cities are given in *figure 2.11*, where a relationship is noticed between average household vehicle availability and the percentage of households with at least one vehicle available. The Muscat Area has a 'middle-of-the-range' vehicle availability in comparison to other Gulf cities. Although it has lower vehicle availability than Kuwait City and Doha registered some years ago, (1977, 1982 ), it is ahead of Manama and Muharaq (Bahrain, 1981) and Dubai (1985). These findings indicate that, although the high growth in vehicle availability has already occurred, there is still potential for further growth before saturation is reached at about 90 per cent of households having at least one vehicle available.

The average household vehicle availability in the Muscat Area in 1990 was mostly similar to that of 1985 (1.23, & 1.22 respectively). In 1990 the percentage of households with at least one vehicle available(81.5%) was higher than that in 1985 (72.4%). This reflects the increase in the percentage of households having one vehicle available more than multi-vehicles' households over the past five years(multi-vehicles' households in 1985 26.2% & 1990 24.6%). Different figures emerge when Omani and Non-Omani households are separated, but given the differences in sample size, location covered and survey procedure, the results of the two surveys can be justified. The 1990 figure's were obtained through a Home Interview Survey with a sample of 352 Omani households (66.7%) and 176 non-Omani households (33.3%). This proportion compares favourably with the proportion of Omani to non-Omani population in 1989 (65% to 35%) as in *table 2.5*. In 1985 the Consultant's figures were obtained through a Roadside Interview Survey with a sample of 18,000 trips makers (by private vehicle, commercial vehicle, taxi, minibus and ONTC bus) in the Muscat Area. Therefore, the differences are due to the fact that most of the person trips by public transport and commercial vehicles are usually made by non-Omani people living either in bachelor accommodation or labour camps with very low car availability. High proportion of Omani person trips are usually made by owned private vehicles and mostly as drivers due to the very low occupancy of the private vehicles (see Chapter 3). Therefore, the Home Interview results are considered to be more realistic in terms of vehicle availability than that in the Roadside Interview Survey.

*Figure 2.11*: Vehicle Availability in Selected Arab Cities




Source: 1- Home Interview Survey, Fieldwork, Muscat 1990 2 - Capital Area Transport Study 1985

There are differences in car availability according to household location and nationality. In order to identify the most effective variable which might greatly influence car availability and their variation among the municipalities, three more variables are discussed in terms of their explanatory power: household income, number of employees and number of persons per household.

2.7.3.1: *CAR-AVAILABILITY AND HOUSEHOLD INCOME*

As discussed earlier, 76.7 per cent of the total households in the Muscat Area are in the medium and high income groups, 12.69 per cent in very high income and 10.61 per cent in the lower income group. Car availability is divided into four categories according to each household income group (*Table 2.18*). This classification is useful in a comparative analysis of car availability among Muscat households.

*Table 2.18* shows that households with very high household income have in all cases the highest proportion of multi-car availability, except in the case of non-Omani households where the one-car-available category is higher. All households with very high income have one or more than one car available, while none of the low income households have multi-car availability. Very high proportions of the households in the lower income have no car available. Excluding the low income households, two significant conclusions can be drawn from *table 2.18*. First, the number of households having one car available is inversely proportional to the increase of household income. Second, the number of households having more than one car available is directly proportional to the increase of household income.

*Table 2.18*: Households Income and Car Availability

| | Low income | | | Medium income | | | High income | | | Very high income | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Municipality | 0 | 1 | >2 | 0 | 1 | >2 | 0 | 1 | >2 | 0 | 1 | >2 |
| Muttrah | 80.8 | 19.2 | ---- | 27.1 | 67.1 | 5.8 | 4.1 | 41.7 | 54.2 | ---- | ---- | 100 |
| Boashar | ---- | 100 | ---- | 2.2 | 86.7 | 11.1 | ---- | 61.7 | 38.3 | ---- | 40.6 | 59.4 |
| Seeb | 78.3 | 21.7 | ---- | 12.8 | 80.0 | 7.2 | 3.5 | 37.9 | 58.6 | ---- | 33.3 | 66.7 |
| Al-Amarat | 50 | 50 | ---- | 25.0 | 70.0 | 5.0 | ---- | 50 | 50 | ---- | ---- | 100 |
| Muscat Area | **75.0** | **25.0** | ---- | **19.3** | **73.8** | **6.9** | **2.3** | **48.5** | **49.2** | ---- | **28.4** | **71.6** |
| Omani | 71.7 | 28.3 | ---- | 17.4 | 73.8 | 8.8 | 1.1 | 39.3 | 59.6 | ---- | 13.3 | 86.7 |
| Non-Omani | 90.0 | 10.0 | ---- | 22.3 | 73.8 | 3.9 | 4.9 | 68.3 | 26.8 | ---- | 59.1 | 40.9 |

Source: Home Interview Survey, Fieldwork, Muscat 1990. ( Share in % related to row total)

## 2.7.3.2: *CAR-AVAILABILITY AND HOUSEHOLD EMPLOYEES*

As discussed earlier (section 2.6.2.1), 38.1 per cent of Muscat's households have 1-2 employees, 27.5 per cent have 3-4 employees, 21 per cent have 5-6 employees and 13.4 per cent have more than six employees. Using the same employment groups, and subdividing each group into three categories, car availability is shown in *table 2.19.* The table shows a slight variation in car availability categories according to each employment group and municipality. For the entire Muscat Area, the share of households which have no car and one car available decreases with the increase in number of employed people per household, while share of households which have more than one car increases with the increase in number of employed people per household. This statement can be applied to Omani households. For non-Omani households, share of the households with one car available does not follow the same path.

In almost all of the employment groups, there are households which have no car, with the exception of Boashar municipality. The reason is that only one household of the households surveyed in the whole municipality has no car available. Therefore, it can be said that there is a slightly significant relationship between car availability and number of employed per household, but this relationship is not as high as it is with the household income, (section 2.7.3.1).

*Table 2.19*: Number of Employed People per Household and Car Availability

| Group --> | 1 - 2 Employed | | | 3 - 4 Employed | | | 5 - 6 Employed | | | >6 Employed | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Municipality | 0 | 1 | >2 | 0 | 1 | >2 | 0 | 1 | >2 | 0 | 1 | >2 |
| Muttrah | 39.8 | 54.8 | 5.4 | 23.5 | 60.3 | 16.2 | 15.9 | 43.2 | 40.9 | 4.0 | 36.0 | 60.0 |
| Boashar | 1.9 | 74.1 | 24.0 | ---- | 68.7 | 31.3 | ---- | 52.0 | 48.0 | ---- | 45.5 | 54.5 |
| Seeb | 22.2 | 64.5 | 13.3 | 21.2 | 60.6 | 18.2 | 17.1 | 62.9 | 20.0 | 15.4 | 26.9 | 57.7 |
| Al-Amarat | 11.1 | 66.7 | 22.2 | 33.3 | 55.5 | 11.2 | 42.9 | 42.9 | 14.2 | 25.0 | 62.5 | 12.5 |
| Muscat Area | **23.9** | **63.2** | **12.9** | **17.9** | **62.1** | **20.0** | **14.4** | **51.4** | **34.2** | **10.0** | **37.1** | **52.9** |
| Omani | 23.5 | 60.6 | 15.9 | 20.7 | 56.5 | 22.8 | 15.6 | 49.0 | 35.4 | 10.2 | 36.2 | 53.6 |
| Non-Omani | 24.3 | 65.4 | 10.3 | 13.2 | 71.7 | 15.1 | 6.7 | 66.7 | 26.6 | ---- | 100 | ---- |

Source: Home Interview Survey, Fieldwork, Muscat 1990. ( Share in % related to row total)

### 2.7.3.3: *CAR-AVAILABILITY AND HOUSEHOLD MEMBERS*

The household having 4 to 7 persons is the most common type; it amount to 48 per cent of the total households surveyed. About 24 per cent of the households comprise 1 to 3 members, 20 per cent have 8 to 11 persons and 8 per cent have more than 12 persons shares of the surveyed households. Using the same household size groups, and subdividing each group into three categories, car availability is shown in *table 2.20.*

The table shows irregular variations in car availability according to each employment group and municipality. The share of households with one car available increases and then decreases with increase of the household size, while the share of households having more than one car increases with increasing number of employed per household. In the case of households with no cars, the share of the households decreases with the increase of the household size. This statement can be applied to Omani households, for non-Omani, share of the households with one car available increase, while households with no cars decrease with the increase in the household size.

*Table 2.20*: Household Size and Car Availability

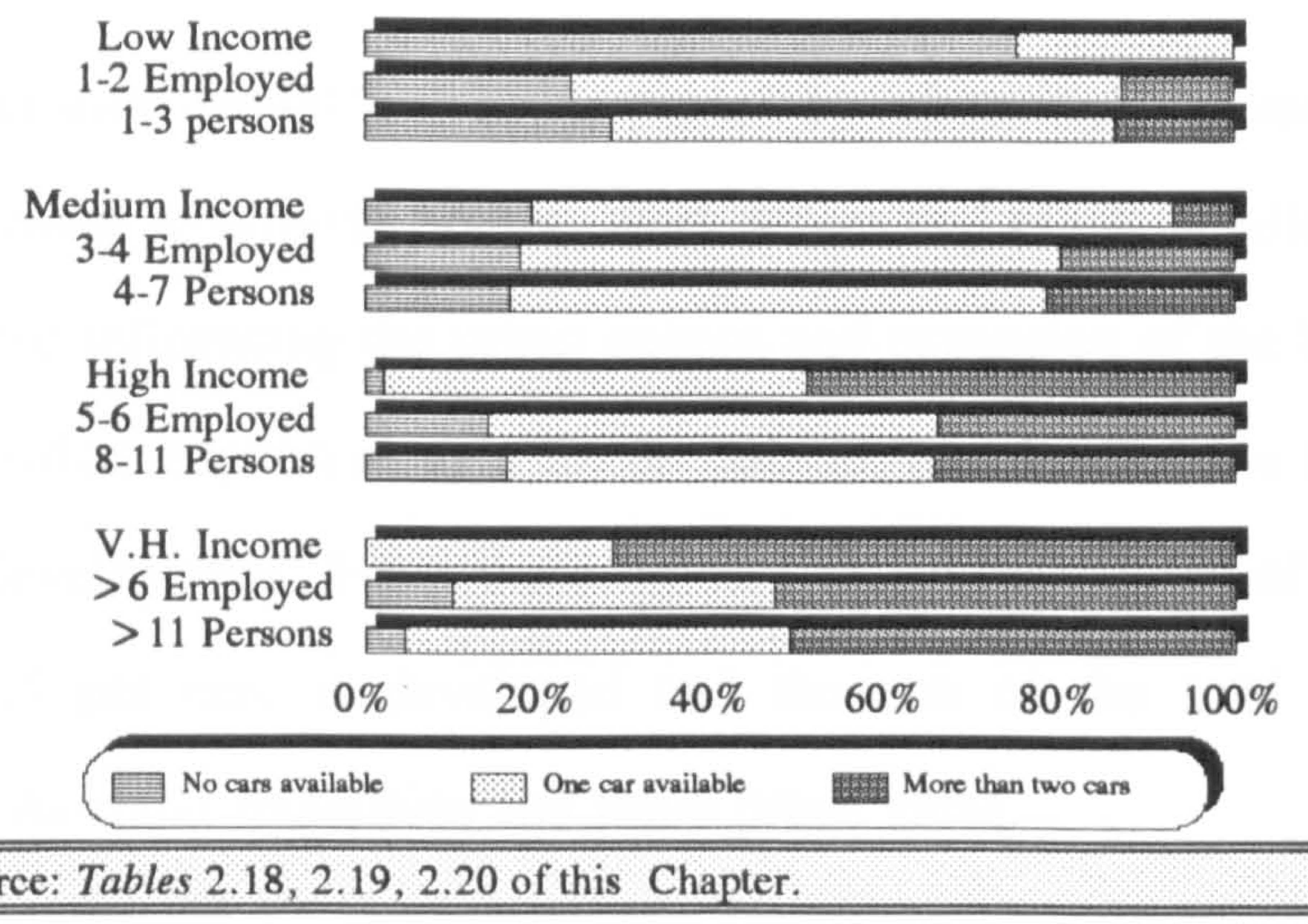
| Group -> | 1--3 Persons | | | 4--7 Persons | | | 8--11 Persons | | | >11 Persons | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Municipality | 0 | 1 | >2 | 0 | 1 | >2 | 0 | 1 | >2 | 0 | 1 | >2 |
| Muttrah | 42.9 | 50.8 | 6.3 | 26.3 | 57.6 | 16.1 | 8.3 | 47.2 | 44.5 | --- | 23.1 | 76.9 |
| Boashar | 2.9 | 67.4 | 29.4 | --- | 68.1 | 31.9 | --- | 50 | 50 | --- | 66.7 | 33.3 |
| Seeb | 25.0 | 67.9 | 7.1 | 17.6 | 60.8 | 21.6 | 24.4 | 46.3 | 29.3 | 10.0 | 45.0 | 45.0 |
| Al-Amarat | 50.0 | -- | 50.0 | 18.8 | 62.4 | 18.8 | 36.4 | 63.6 | -- | --- | 75.0 | 25.0 |
| Muscat Area | **28.3** | **58.3** | **13.4** | **16.9** | **61.4** | **21.7** | **16.4** | **49.0** | **34.6** | **4.7** | **44.2** | **51.1** |
| Omani | 35.6 | 48.9 | 15.5 | 18.0 | 55.9 | 26.1 | 16.5 | 48.5 | 35.0 | 4.7 | 44.2 | 51.1 |
| Non-Omani | 24.4 | 63.4 | 12.2 | 15.0 | 71.0 | 14.0 | --- | 100 | --- | -- | -- | -- |

Source: Home Interview Survey, Fieldwork, Muscat 1990. ( Share in % related to row total)

As seen in *table 2.20,* the relationship between car availability and the household size is not clear at the municipal level as in the entire Muscat Area. Therefore, it can be said that a less significant relationship exists between car availability and household size as seen in sections 2.7.3.1 and 2.7.3.2.

In brief, *Figure 3.12* shows the relationship between the car availability and each of the three variables of household size, employment and income. There is a significant relationship between car availability and each of the variables, but it is more significant in the case of household income. Therefore, it can be said that the household income is the most important variable in car availability, followed by number of employed per household. Number of persons per household has less effect on car availability compared with household income and number of employed people.

*Figure 3.12*: Household Characteristics and Car Availability




Source: *Tables* 2.18, 2.19, 2.20 of this Chapter.

## 2.8: CONCLUSION

The population of the Muscat Area has considerably increased from 25,000 persons in 1970 to 417,000 in 1990. This huge increase in the population was due mainly to the fact that the government pumped large proportions of the oil revenue into economic and social projects. This economic boom led to rural-urban migration and expatriate movements in the direction of Muscat Area to fill jobs generated by the strong economy. The increase of non-Omani population is evident from *table 2.5*, in which the average annual growth rate (AAGR) reached as high as 27.3 per cent during the years of heavy development spending. The non-Omani population in the Muscat Area accounts for 35 per cent of the total population.

The increase in the Omani population resulted from improved heath and social services which have led to an increase in life expectancy and the high proportion of youngsters among the population. Besides, large numbers of exiled Omanis flocked back from abroad after the new government took over in 1970. The opportunity to earn a better income and attain a more desirable life style led to a lot of young Omanis to leave the rural areas for the Muscat Area. The main reason for rural-urban immigration in Oman is the concentration of government administrations, public services and other relative activities in the Muscat Area.

This huge population growth was accompanied by substantial expansion of Muscat's boundaries in order to provide homes, work places and other facilities. Topography is a major factor influencing the urban pattern and expansion of the Muscat Area. It restricted the urban expansion to a linear fashion, and limited the amount of land required for development. From the estimated total Muscat area of 2,300 sq. km. only about 6.5 per cent is developed and the rest of the total area is mostly dominated by Al-Hajar mountains and flood prone areas.

The expansion of the Muscat Urban Area was attended by changes in employment and residential pattern. The government controls the distribution of residential plots to the people, therefore, the citizen has to accept the granted plot whether it is near to or far away from his working place, since the price of the residential plots are very expensive in the local market. The average of people working or schooling in the traffic zone where they live is around 31 per cent for males and 43 per cent for females. Excluding male and female students from the above figures due to the proper distribution of schools among the traffic zones, the proportion of people working outside their living traffic zone is anticipated to be very high.

Most of the households in the Muscat Area have a car available. The number of cars per person and per household is significantly high compared with the rest of the Middle East cities. The major factors which played an important role in increasing car availability per household are:

1) - Household characteristics, such as, income, number of members employed and household population. Income is a major factor affecting car availability per household. The high proportion of household income resulted from the availability of free essential services, such as, health care and education, and absence of taxes and duties. The high number of employed persons per household and the high population per household also contributed to the increase of car availability.

2) - The expansion of the Muscat Area and the accompanying changes in employment and residential pattern, the lack of internal waterway and fixed track system, and the unreliability of public transport resulted in a significant increase in the number of cars. In addition, the relatively low cost of locally produced petrol, and the low customs duty on vehicles led to reasonably low motor car prices, hence more people became car owners.

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# CHAPTER 3
# THE CHARACTERISTICS
# OF PERSONAL TRAVEL IN MUSCAT AREA

## 3.0 - INTRODUCTION

The planning, design and management of the road transportation system depends greatly on the availability of reliable, relevant and recent travel data, and the ability to analyse and interpret these data. The physical and development characteristics of the study area (Chapter 2) are very significant in interpreting and determining travel movement characteristics. The purpose of this chapter is to give a clear picture of the where, how, why and when of all personal travel in the Muscat Area during a typical weekday. This is followed by a detailed description of trip generation rates.

In contradiction to the term "traffic", which is generally applied to vehicles on roads, personal travel comprises the movement of people by private and commercial vehicles, public transport, cycle and on foot. The basic unit of measurement of personal travel in this study is the "person trip". This is defined as a one-way movement between an origin and a destination for one purpose, and by one means of transport. For example, a journey involving a walk, a bus ride and a walk would be one trip by bus. In the Roadside Interview, interviews were carried out with vehicle drivers only, therefore person trips in fact represent vehicle trips.

The personal travel analysis is intended to represent personal trips undertaken by 2662 persons interviewed in the Study Area, and 812 vehicle drivers interviewed in their journeys entering the Muscat Area boundary, under five general headings: -

1 - Where people travel
2 - How people travel
3 - Why people travel
4 - When people travel
5 - Trip generation rates

A person trip is analysed in depth under each heading in order to establish fundamental relationships between personal travel and the factors that govern it, and also to provide a firm base for the following chapters.

## 3.1 - WHERE PEOPLE TRAVEL

### 3.1.1: *CLASSIFICATION OF TRAVEL MOVEMENTS*

This section discusses personal trips undertaken by 2662 persons living in the Muscat Area, and 812 vehicle drivers interviewed in their journeys entering Muscat boundary. Every trip made by persons within or into the Study Area is represented. It is necessary, therefore, to consider the different kinds of trips made and to find the most reliable and meaningful means of sampling each type. Therefore, person-trips are classified under three general headings on the basis of the location of their origins and destinations:

1 - *Internal trips* - with both origin and destination inside the Muscat Area;
2 - *External trips* - with one end inside and the other end outside the Muscat Area; and
3 - *Through trips* - trips with both ends outside the Muscat Area.

#### 3.1.1.1 - RESIDENT-PERSON TRIPS

*Table 3.1* shows a breakdown into basic trip classifications of all person-trips made by the residents of the 528 households in the Study Area. The vast bulk of personal movements in the Muscat Area are internal movements, 98.8 per cent of the personal trips on a typical weekday are internal. Of the total internal person-trips, 22.9 per cent are unmotorised. External trips made by the residents account for 1.2 per cent of the total, therefore, most of the following analysis is confined to internal travel.

*Table 3.1*: Classifications of Person-trips Made by Resident of the Study Area .

| Type of Trips | Trip Classification | Omani | | Non-Omani | | Total | Per cent tage |
|---|---|---|---|---|---|---|---|
| | | Male | Female | Male | Female | | |
| Internal trips | Unmotorised | 1242 | 330 | 180 | 70 | **1822** | 22.9% |
| | Motorised | 3067 | 1248 | 1261 | 471 | **6047** | 75.9% |
| | Sub-total ---> | 4309 | 1578 | 1441 | 541 | **7869** | 98.8% |
| External Trips | Motorised | 54 | 22 | 8 | 8 | **92** | 1.2% |
| **Total** | | **4363** | **1600** | **1449** | **549** | **7961** | 100% |

Note: All trips are representing 24 hour total trips of 2662 persons over 5 years old living in 528 households in the Muscat Area ( Source: Home Interview Survey).

3.1.1.2 - INBOUND VEHICLE TRIPS

A high proportion of traffic movement across the Muscat Area boundary is internal destination trips. As shown in *table 3.2*, 93.1 per cent of the vehicle trips entering the Study Area end within it. Through trips, which pass through the Muscat Area without a significant stop share 6.9 per cent of the total. The table shows that total vehicles interviewed account for 9.2 per cent in cordon point one and 14.5 per cent in cordon point two of the actual traffic that entered the Study Area boundary during the 12 hour of the Roadside Interview at each station (0600 to 1800 hours).

*Table 3.2*: Classifications of Vehicle Drivers Travel Entering the Muscat Area

| Type of Trips | Cordon Point One | | Cordon Point Two | | Total trips | Percentage |
|---|---|---|---|---|---|---|
| | Interviewed | Entered | Interviewed | Entered | | |
| External Trips | 401 | Study Area | 355 | Study Area | 756 | 93.1% |
| Through Trips | 23 | 4602 | 33 | 2680 | 56 | 6.9% |
| **Total** | **424** | ------> | **388** | ------> | **812** | **100%** |

Source: Roadside Interview , fieldwork, Muscat 1990

3.1.2 : *GEOGRAPHICAL DISTRIBUTION*

3.1.2.1 - GENERAL

As discussed earlier (Chapter 2), there are 25 internal traffic zones and 8 external traffic zones. Studying all trip movements recorded in the interview studies in terms of observed trip matrixes (inner zone, zone-to-zone and internal zone to external zone movements) with the survey samples was considered inadequate to measure accurately all of those possible individual movements. The Institution of Highway and Transportation in the UK suggested:

> Observed trip matrix is usually only practicable for small study areas, Unless large zone sizes are acceptable, but it does represent actual travel patterns reliably if the surveys have been carried out on a sufficiently large scale.(1)

Accordingly, trips recorded in the surveys were mainly accumulated to provide municipality to municipality or municipality to external cordon station (outer area) movements. The patterns of inter-zonal movements in the Muscat Area are presented in *table 3.3* to show the scale of these movements. The intra-zonal movements share a high proportion of the total personal trips, due to the fact that most of the walking trips are intra-zonal trips.

*TABLE 3.3* : DISTRIBUTION OF TOTAL NUMBER OF INTERNAL PERSON TRIPS BY TRAFFIC ZONE (Source: Fieldwork, Muscat 1990)

| ORIGIN | <--- DESTINATION AREA CODES ---> | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AREAS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | Total |
| 1 | 66 | 20 | 20 | 12 | 10 | 2 | 5 | 4 | 5 | 0 | 6 | 1 | 0 | 3 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 3 | 0 | 0 | 1 | 161 |
| 2 | 20 | 181 | 42 | 43 | 24 | 9 | 5 | 21 | 4 | 1 | 18 | 3 | 0 | 2 | 2 | 0 | 3 | 6 | 7 | 0 | 1 | 2 | 1 | 2 | 6 | 403 |
| 3 | 19 | 37 | 239 | 124 | 68 | 20 | 15 | 21 | 2 | 9 | 23 | 4 | 2 | 2 | 3 | 2 | 6 | 11 | 6 | 1 | 5 | 1 | 1 | 4 | 4 | 626 |
| 4 | 11 | 40 | 121 | 384 | 147 | 80 | 50 | 56 | 25 | 5 | 58 | 8 | 4 | 12 | 8 | 0 | 9 | 23 | 12 | 1 | 5 | 2 | 3 | 8 | 7 | 1079 |
| 5 | 8 | 34 | 55 | 152 | 368 | 45 | 55 | 80 | 17 | 5 | 55 | 16 | 12 | 16 | 5 | 0 | 2 | 10 | 9 | 1 | 5 | 2 | 5 | 8 | 16 | 978 |
| 6 | 2 | 4 | 25 | 76 | 47 | 64 | 11 | 12 | 3 | 1 | 9 | 4 | 0 | 4 | 2 | 0 | 4 | 8 | 1 | 1 | 1 | 1 | 1 | 3 | 0 | 284 |
| 7 | 4 | 8 | 13 | 47 | 57 | 13 | 44 | 16 | 18 | 2 | 17 | 3 | 3 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 2 | 2 | 1 | 4 | 13 | 271 |
| 8 | 7 | 19 | 21 | 58 | 64 | 8 | 21 | 128 | 24 | 12 | 79 | 10 | 9 | 2 | 5 | 1 | 8 | 2 | 6 | 2 | 0 | 1 | 0 | 6 | 3 | 496 |
| 9 | 6 | 2 | 2 | 30 | 18 | 2 | 18 | 25 | 131 | 10 | 44 | 15 | 7 | 3 | 1 | 0 | 4 | 2 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 325 |
| 10 | 0 | 1 | 9 | 3 | 3 | 0 | 0 | 17 | 14 | 5 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 64 |
| 11 | 9 | 19 | 23 | 58 | 47 | 17 | 17 | 60 | 44 | 8 | 185 | 32 | 17 | 14 | 14 | 6 | 10 | 19 | 13 | 4 | 13 | 2 | 2 | 4 | 3 | 640 |
| 12 | 1 | 1 | 6 | 10 | 23 | 2 | 2 | 8 | 16 | 2 | 33 | 20 | 10 | 0 | 3 | 0 | 6 | 1 | 9 | 1 | 3 | 0 | 0 | 0 | 8 | 165 |
| 13 | 0 | 1 | 3 | 4 | 12 | 0 | 2 | 3 | 7 | 0 | 15 | 12 | 33 | 5 | 6 | 3 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 111 |
| 14 | 1 | 1 | 2 | 14 | 16 | 4 | 1 | 7 | 1 | 0 | 13 | 2 | 4 | 8 | 2 | 0 | 2 | 3 | 4 | 1 | 1 | 0 | 3 | 0 | 0 | 90 |
| 15 | 1 | 3 | 7 | 8 | 6 | 1 | 0 | 8 | 1 | 0 | 9 | 4 | 2 | 2 | 13 | 0 | 6 | 1 | 14 | 5 | 4 | 6 | 0 | 1 | 0 | 102 |
| 16 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 5 | 0 | 3 | 1 | 0 | 42 | 7 | 1 | 7 | 0 | 1 | 0 | 3 | 0 | 1 | 75 |
| 17 | 0 | 5 | 6 | 7 | 4 | 3 | 1 | 8 | 3 | 0 | 11 | 9 | 3 | 3 | 8 | 7 | 116 | 18 | 34 | 1 | 10 | 6 | 5 | 0 | 0 | 268 |
| 18 | 0 | 6 | 11 | 19 | 13 | 8 | 3 | 4 | 2 | 1 | 18 | 1 | 0 | 3 | 5 | 1 | 22 | 119 | 41 | 3 | 6 | 9 | 7 | 1 | 1 | 304 |
| 19 | 0 | 8 | 12 | 10 | 9 | 1 | 1 | 3 | 2 | 1 | 12 | 9 | 2 | 4 | 6 | 8 | 36 | 47 | 330 | 48 | 44 | 6 | 3 | 0 | 2 | 604 |
| 20 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 3 | 0 | 0 | 4 | 1 | 0 | 1 | 5 | 0 | 0 | 4 | 48 | 72 | 8 | 0 | 5 | 0 | 0 | 154 |
| 21 | 1 | 1 | 5 | 5 | 7 | 1 | 2 | 0 | 2 | 4 | 5 | 4 | 0 | 1 | 4 | 0 | 11 | 8 | 47 | 8 | 36 | 0 | 1 | 0 | 0 | 153 |
| 22 | 3 | 2 | 0 | 3 | 2 | 1 | 2 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 6 | 0 | 5 | 9 | 5 | 0 | 0 | 28 | 1 | 0 | 1 | 73 |
| 23 | 0 | 1 | 1 | 3 | 6 | 0 | 1 | 0 | 1 | 0 | 3 | 0 | 0 | 2 | 0 | 3 | 5 | 8 | 3 | 5 | 1 | 1 | 0 | 0 | 0 | 44 |
| 24 | 0 | 3 | 3 | 8 | 5 | 3 | 4 | 7 | 1 | 0 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 89 | 23 | 152 |
| 25 | 1 | 5 | 2 | 7 | 18 | 1 | 13 | 3 | 0 | 0 | 2 | 7 | 0 | 2 | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 22 | 158 | 247 |
| Total | 160 | 402 | 628 | 1087 | 971 | 286 | 273 | 498 | 323 | 67 | 638 | 165 | 111 | 90 | 101 | 74 | 266 | 305 | 603 | 154 | 150 | 74 | 43 | 153 | 247 | 7869 |

| | | | | |
|---|---|---|---|---|
| 1 - Sidab, Bustan, Quntab | 6 - Wadi Kabir | 11 - Al-Khuwair | 16 - Mawelah | 21 - Ma'abela |
| 2 - Muscat town | 7 - Wattayah | 12 - Ghobra, Boashar town | 17 - Al- Hail | 22 - Qaboos University Complex |
| 3 - Muttrah town | 8 - Qurum | 13 - Adhuba | 18 - Al-Khod | 23 - Ryseil Industrial State |
| 4 - Darseit, Ruwi North, CDB | 9 - Qaboos City , Int. City | 14 - Ghala | 19 - Seeb towm | 24 - Al - Amarat town |
| 5 - Ruwi S, Hamriya, Wadi adai | 10 - Qurum Beach , Dipl. Area | 15 - Airport and Airport Hights | 20 - Manuma | 25 - Madinat Al-Nahda |

### 3.1.2.2 - RESIDENTS PERSON TRIPS DISTRIBUTION

The geographical distribution of daily personal travel in terms of origin and destination of the Muscat Area residents is shown in *table 3.4.* Evidently the eastern Muscat Area accounts for the majority of personal movements. About 45 per cent of total internal personal trips have at least one end within Greater Muttrah and more than 33 per cent are made entirely within this municipality. Al-Amarat has the lowest proportions of personal movements. Only 5.1 per cent of the trips have one end within this municipality, while trips having both ends within it account for 3.8 per cent. Trips with one end outside the Study Area (residents external trips) account for 1.2 per cent of total resident trips. More than half of the resident external trips have at least one end within Boashar municipality.

*Table 3.4*: Geographical Pattern of Personal Travel in the Study Area,

| Origin Area | <--------- Internal Destination Area ----------> | | | | | | | | | | Destination Outer Area | | Total Trips | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Muttrah | | Boashar | | Seeb | | Amarat | | Sub-total | | | | | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) | NO | (%) | No. | (%) |
| Muttrah | 2613 | 33.2% | 674 | 8.6% | 185 | 2.4% | 59 | 0.7% | 3531 | 44.9% | 9 | 9.8% | 3540 | 44.5% |
| Boashar | 669 | 8.5% | 1267 | 16.1% | 184 | 2.3% | 42 | 0.5% | 2162 | 27.4% | 25 | 27.1% | 2187 | 27.4% |
| Seeb | 196 | 2.5% | 181 | 2.3% | 1393 | 17.7% | 7 | 0.1% | 1777 | 22.6% | 12 | 13.1% | 1789 | 22.5% |
| Amarat | 56 | 0.7% | 43 | 0.5% | 8 | 0.1% | 292 | 3.8% | 399 | 5.1% | 0 | 0.0% | 399 | 5.0% |
| Subtotal | 3534 | 44.9% | 2165 | 27.5% | 1770 | 22.5% | 400 | 5.1% | 7869 | 100% | 46 | 50.0% | 7915 | 99.4% |
| Outer Area | 7 | 7.6% | 26 | 28.2% | 13 | 14.1% | 0 | 0.0% | 46 | 50.0% | 0 | 0.0% | 46 | 0.6% |
| Total trips | 3541 | 44.5% | 2191 | 27.5% | 1783 | 22.4% | 400 | 5.0% | 7915 | 99.4% | 46 | 0.6% | 7961 | 100% |

Source: Home Interview Survey, Fieldwork, Muscat 1990 (share in % related to both column & row total

*Figure 3.1* shows diagrammatically the relative sizes of the bulk of municipality to municipality personal movements. The figure confirms that Greater Muttrah is the centre of attraction for the other municipalities. It is also noticeable that Boashar has a high movement rate to and from Muttrah than it does to and from Seeb municipality and Al-Amarat.

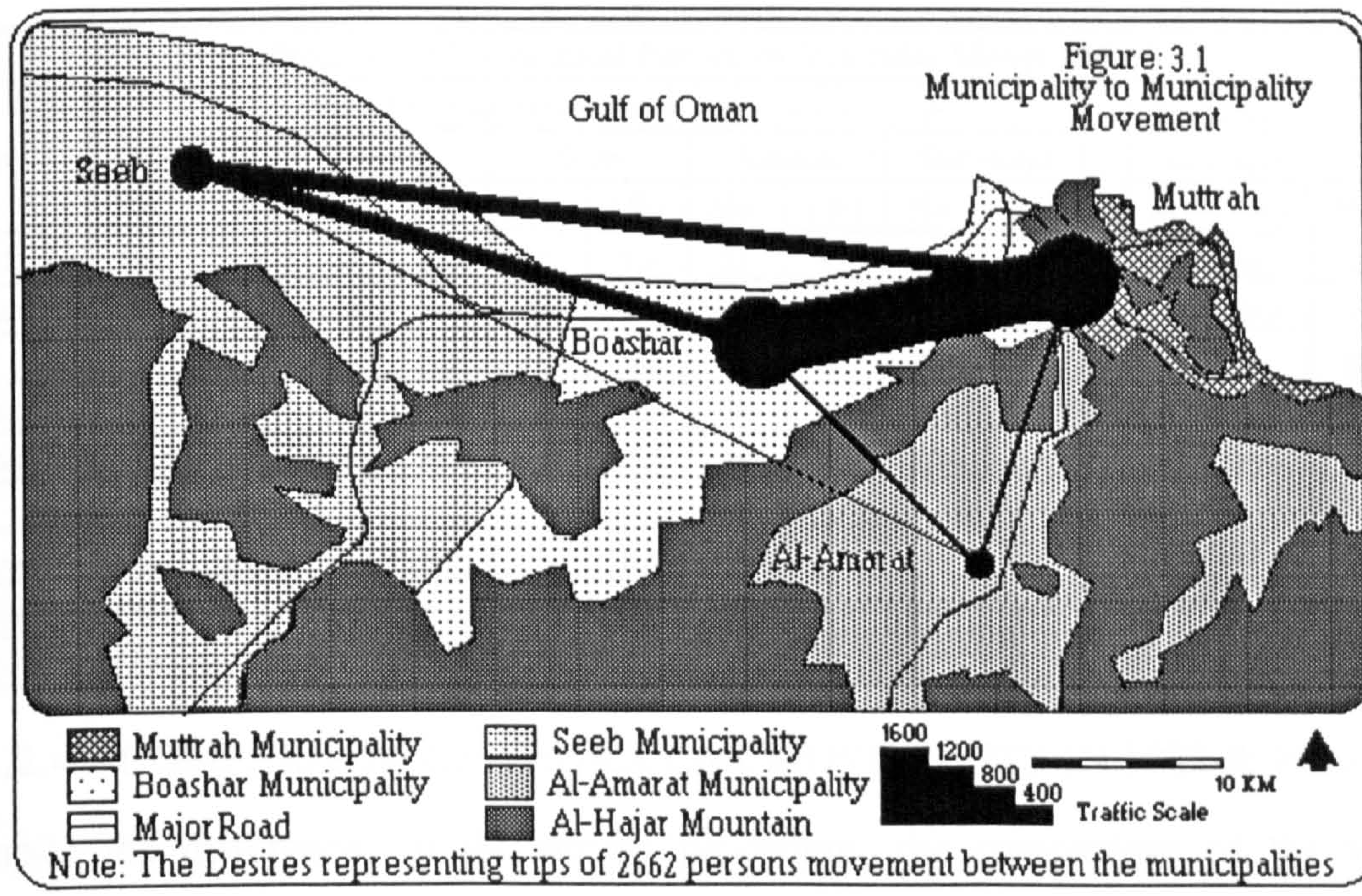



Figure: 3.1 Municipality to Municipality Movement

Note: The Desires representing trips of 2662 persons movement between the municipalities

3.1.2.3 - RESIDENTS' VEHICLE TRIPS

As seen previously, 7961 trips are made by 2662 persons living in the Muscat Area. Out of the total trips, 3014 trips are made by persons driving a vehicle during their journeys, in other words, those trips are vehicle movements. The analysis also reveals that 1999 trips are made by Omani drivers and 1015 by non-Omani. Female drivers make 388 trips (12.9% of all trip made by persons driving a vehicle) of which 122 trips are made by non-Omani female.

*Table 3.5* Shows the distribution of vehicle movements. About 42 per cent of all trips have at least one end within Greater Muttrah, this is three per cent less compared to that in the personal-travel movements. Trips having both ends within Greater Muttrah account for 26.2 per cent and this is also less by seven per cent. In Boashar, such trips are higher by ten and five per cent respectively. In Seeb and Al-Amarat, trips having one end and both ends within them are lower in both cases than that in the personal-travel movements. Therefore, it can be said that Boashar municipality (with the highest car availability and household income in the Muscat Area) has the highest vehicle movement rate.

*Table 3.5:* Geographical Pattern of Vehicular Movements

| Origin Area | <--------- Internal Destination Area -----------> | | | | | | | | | | Destination Outer Area | | Total Trips | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Muttrah | | Boashar | | Seeb | | Amarat | | Sub-total | | | | | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) | NO | (%) | No. | (%) |
| Muttrah | 784 | 26.2 | 364 | 12.2 | 73 | 2.4 | 25 | 0.9 | 1246 | 41.7 | 4 | 15.3 | 1250 | 41.5 |
| Boashar | 359 | 12.0 | 639 | 21.4 | 89 | 3.0 | 19 | 0.6 | 1106 | 37.0 | 7 | 27.0 | 1113 | 36.9 |
| Seeb | 80 | 2.7 | 86 | 2.9 | 388 | 13.0 | 4 | 0.1 | 558 | 18.7 | 2 | 7.7 | 560 | 18.6 |
| Amarat | 23 | 0.8 | 20 | 0.6 | 5 | 0.2 | 30 | 1.0 | 78 | 2.6 | 0 | 0.0 | 78 | 2.6 |
| Subtotal | 1246 | 41.7 | 1109 | 37.1 | 555 | 18.6 | 78 | 2.6 | 2988 | 100 | 13 | 50.0 | 3001 | 99.6 |
| Outer Area | 3 | 11.5 | 7 | 27.0 | 3 | 11.5 | 0 | 0.0 | 13 | 50.0 | 0 | 0.0 | 13 | 0.4 |
| Total trips | 1249 | 41.4 | 1116 | 37.1 | 558 | 18.5 | 78 | 2.6 | 3001 | 99.6 | 13 | 0.4 | 3014 | 100 |

Source: Home Interview Survey, Fieldwork, Muscat 1990 (share in % related to column & row total)

### 3.1.2.4 - COMPARISON OF VEHICULAR MOVEMENTS IN 1985 & 1990

Despite the differences in the survey procedure, the comparison of the vehicle movements as found from the 1985 Roadside Interview Survey and 1990 Home interview Survey is shown in *table 3.6*. The share of total vehicle trips having one end within Greater Muttrah decreased from 57 to 41.1 per cent, and also trips made entirely within the municipality decreased from 41.6 to 26.0 per cent over the past five years. In the other municipalities, the share of all vehicle movements between 1985 and 1990 increased in both cases, reflecting the increase of their population over the past five years, as well as their shares on the total Muscat Area population increased from that in 1985 compared with Greater Muttrah.

*Table 3.6*: Comparison of Distribution of Vehicle Trips by District in 1985 & 1990.

| Municipality | (%) of Total Vehicle Trips with one end within District | | (%) of Total Vehicle Trips with both ends within District | |
|---|---|---|---|---|
| | 1985 (cats) | 1990 (Fieldwork) | 1985(cats) | 1990(Fieldwork) |
| Muttrah | 57.0% | 41.4% | 41.6% | 26.0% |
| Boashar | 30.1% | 37.1% | 15.4% | 21.2% |
| Seeb | 8.6% | 18.5% | 3.2% | 12.9% |
| Al-Amarat | 1.9% | 2.6% | 0.1% | 1.0% |
| External | 2.4% | 0.4% | 0.2% | 0.0% |
| Total | 100% | 100% | 60.7% | 61.1% |

Source : 1- Capital Area Transport Study (cats - Roadside Interview)1985" table 3.8"
2 -Home Interview Survey, Fieldwork 1990 ( Share in % related to column total)

### 3.1.2.5 - INBOUND VEHICLE TRIPS DISTRIBUTION

The basic pattern of traffic movements entering the Muscat Area during the Roadside Surveys in terms of cordon point to municipality and cordon to cordon point is shown in *table 3.7*. The results indicate that 93 per cent of the trips entering the Muscat Area have destinations within it, while the trips passing through the Study Area account for 7 per cent. Clearly the Al-Batinah region(Area no. 26) emerges as the highest external traffic generation zone. More than 51 per cent of the trips end within the Muscat Area and 40 per cent of the total passing trips are generated from Al-Batinah. It can also be seen that more than 43 per cent of total internal destination trips are attracted to the Seeb municipality, reflecting its adjacent location to the three major traffic generations zones{Al-Batinah, A'Dakhliya(27) & A'Sharqiya (28)}. Most of the trips passing through the Study Area have least one end in Al-Batinah and the other end either in A'Dakhliya or A'Sharqiya.

*Table 3.7*: Distribution of External and Through Vehicle Travel (12-hour day)

| Cordon Point | Origin Area | Internal Area Destination: Muttrah | Boashar | Seeb | Amarat | Total No. | Total (%) | Outer area Destination: Cordon 1: 26 | 32 | Cordon point 2: 27 | 28 | 30 | Total No | Total (%) | Overall Total No. | Overall Total (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **One** | 26 | 93 | 112 | 181 | 3 | 389 | 51.4% | --- | --- | 9 | 12 | 2 | 23 | 41.0% | 412 | 50.7% |
| | 32 | 1 | 2 | 5 | 0 | 8 | 1.0% | --- | --- | 0 | 0 | 0 | 0 | 0% | 8 | 1.0% |
| | 33 | 2 | 2 | 0 | 0 | 4 | 0.5% | --- | --- | 0 | 0 | 0 | 0 | 0% | 4 | 0.5% |
| **Two** | 27 | 68 | 60 | 113 | 2 | 243 | 32.1% | 16 | 0 | --- | --- | --- | 16 | 28.6% | 259 | 31.9% |
| | 28 | 48 | 25 | 24 | 1 | 98 | 13.0% | 8 | 9 | --- | --- | --- | 17 | 30.4% | 115 | 14.2% |
| | 29 | 6 | 3 | 4 | 0 | 13 | 1.7% | 0 | 0 | --- | --- | --- | 0 | 0% | 13 | 1.6% |
| | 30 | 0 | 1 | 0 | 0 | 1 | 0.3% | 0 | 0 | --- | --- | --- | 0 | 0% | 1 | 0.1% |
| Total trips | | 218 | 205 | 327 | 6 | 756 | 100% | 24 | 9 | 9 | 12 | 2 | 56 | 100% | 812 | 100% |

Source: Roadside Interview Survey, Fieldwork, Muscat 1990 ( Sample size 812 Vehicle Drivers)
Note: External traffic zones (areas) have not generated or attracted trips are excluded. See App'x "B"

*Figure 3.2* shows diagrammatically the pattern of internal destination traffic and through traffic movements from each cordon point of entry. As seen previously in *figure 3.1*, Muttrah is the centre of attraction for internal personal travel. For internal destination traffic Seeb plays the same role as Muttrah, where the great majority of trips which enter the Study Area end within the Seeb municipality. The adjacent location of the municipality to the external zones encourages this high proportion of movements.

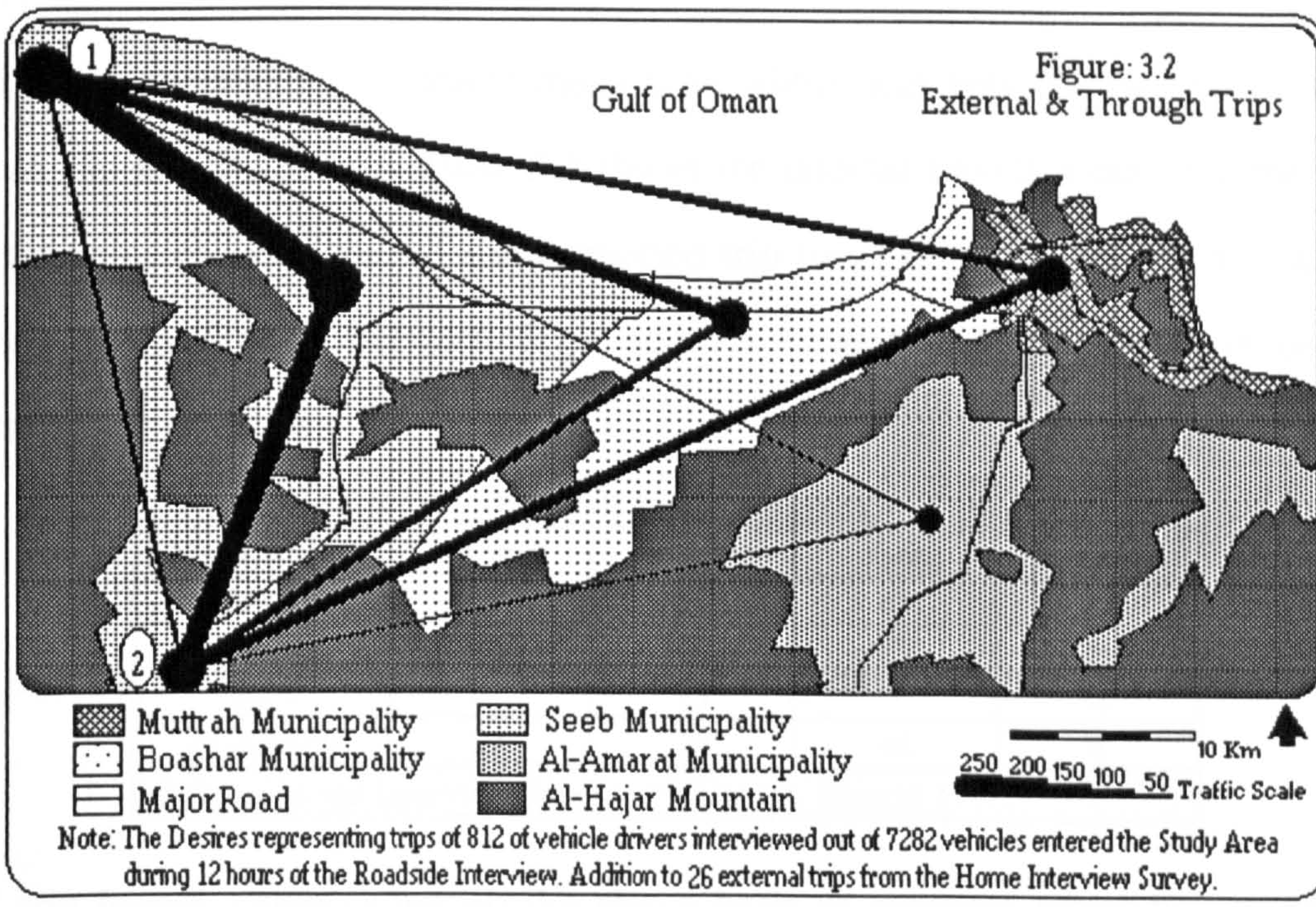



Figure: 3.2 External & Through Trips

### 3.1.3 - *RESIDENTS TRIP LENGTH*

Regularity of personal travel is evidenced in another important way: the number of trips made varies systematically with trip length. Short trips are made most frequently and progressively fewer are made as trip length increases[2]. Because traffic zones and municipalities were defined with regard to neighbourhood groupings, the extent to which traffic is local to an area, i.e. an indication of its trip length, can be obtained by classifying trips according to whether they are: -

1 - *Short trips* -- occurring wholly within traffic zones.
2 - *Medium trips* occurring between zones but wholly within municipalities.
3 - *Long trips* -- occurring between municipalities but wholly within the Muscat Area.
4 - *External trips* Occurring between the Study Area and point outside it.

The above classification is based on an assumption that trips occur between all the traffic zone centroids. This assumption is adopted to simplify the analysis of trip length. It is obvious that not all trips commence and terminate at a zone centroid, besides, in some cases, for example, length of the trip occurring wholly within a particular zone could be longer than that occurring between zones.

It is worth speculating on travel mean time within and between the municipalities before trip length analysis. *Table 3.8* shows the internal travels mean time matrix by private vehicles as calculated from reported trip times of departure and arrival. The highest mean time is between Seeb and Al-Amarat and the lowest is between Muttrah and Boashar.

*Table 3.8:* Internal travels mean time by vehicles (minutes)

| Municipality | Muttrah | Boashar | Seeb | Al-Amarat |
|---|---|---|---|---|
| Muttrah | 8 | 16 | 41 | 22 |
| Boashar | 16 | 6 | 23 | 24 |
| Seeb | 42 | 23 | 7 | 46 |
| Al-Amarat | 23 | 24 | 46 | 4 |

Source: Home Interview Survey, Fieldwork, Muscat 1990

The trip length classification on the above basis of personal travel by residents of the Muscat Area is shown in *table 3.9.* An alternative and more general indication of the trip length is the proportion of trips taking place wholly within traffic zones. Some 2859 person trips (36 per cent of total residents trips) are intra-zonal trips. This proportion tends to be higher in the Omani population and lower in the non-Omani population. The number of trips decreases as trip length increase in terms of Omani and overall population, while in the non-Omani number of medium trips is higher than short trips.

*Table 3.9*: Classification of Travel by Trip Length (24-hour trips)

| Trip length category | Omani population | | | Non-Omani population | | | All population | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | (%) | Trip/person | No. | (%) | Trip/person | No. | (%) | Trip/person |
| Short trips | 2238 | 38% | 1.11 | 621 | 31% | 0.95 | **2859** | **36%** | **1.07** |
| Medium trips | 1958 | 33% | 0.98 | 748 | 37% | 1.15 | **2706** | **34%** | **1.02** |
| Long trips | 1691 | 28% | 0.84 | 613 | 31% | 0.94 | **2304** | **29%** | **0.87** |
| Sub-total (Internal) | **5887** | **99%** | **2.93** | **1982** | **99%** | **3.04** | **7869** | **99%** | **2.96** |
| External trips | 76 | 1% | 0.04 | 16 | 1% | 0.02 | **92** | **1%** | **0.03** |
| Total person trips | **5963** | **100%** | **2.97** | **1998** | **100%** | **3.06** | **7961** | **100%** | **2.99** |

Source: Home Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to column total)

### 3.1.3.1 - PERSON POSITION AND TRIP LENGTH

In order to explore pattern of trip length according to each person's position in the household, household members were classified into the following categories on the basis of their relationship to the head of the household: -

| | |
|---|---|
| 1 - Head of the household | 2 - Husband or Wife |
| 3 - Farther or Mother | 4 - Son or Daughter |
| 5 - Brother or Sister | 6 - Other Relatives |
| 7 - Servant | 8 - Friend |

*Table 3.10* shows the proportion of trip length for each of the above categories. Position three appears as the category with the highest proportion of short trips followed by position seven, while position eight has the lowest proportion follow by positions one and two. The statement that the number of trips decreases as trip length increases applies to only three of the categories (3,4 & 6). In the others the share of medium trips is higher than short trips, with the exception of position seven where the proportion of medium trips is lower than short trips. In addition, position one, two and eight the share of long trips is also higher than short trips, but less than medium trips. The share of the external trip is very low, and it varies between zero and one per cent as seen in the table.

*Table 3.10*: Effect of the Position of the Member of the Household on Trip Length

| Trip length category | Position 1 | | Position 2 | | Position 3 | | Position 4 | | Position 5 | | Position 6 | | Position 7 | | Position 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No | % | No. | % | No | % | No | % | No | % | No | % | No | % |
| Short trips | 849 | *29* | 281 | *29* | 60 | *62* | 1339 | *44* | 100 | *32* | 137 | *41* | 82 | *50* | 11 | *10* |
| Med. trips | 1052 | *37* | 375 | *39* | 21 | 22 | 940 | *30* | 124 | *39* | 123 | *37* | 22 | *13* | 49 | *46* |
| Long trips | 951 | *33* | 303 | *31* | 15 | *16* | 771 | *25* | 88 | *28* | 70 | *21* | 60 | *36* | 46 | *44* |
| Sub total | **2852** | ***99*** | **959** | ***99*** | **96** | ***100*** | **3050** | ***99*** | **312** | ***99*** | **330** | ***99*** | **164** | ***99*** | **106** | ***100*** |
| Exter'l trip | 32 | *01* | 14 | *01* | 00 | *00* | 36 | *01* | 4 | *01* | 4 | *01* | 2 | *01* | 0 | *00* |
| Total | **2884** | ***100*** | **973** | ***100*** | **96** | ***100*** | **3086** | ***100*** | **316** | ***100*** | **334** | ***100*** | **166** | ***100*** | **106** | ***100*** |

Source: Home Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to column total)

### 3.1.3.2 - AGE AND TRIP LENGTH

The effect of a person's position on the trip lengths is discussed earlier. Here the effect of a person's age on the trip length is discussed. *Table 3.11* shows the effect of age on trip length. To simplify the analysis, age is classified into six groups as used in the Home Survey and shown in *table 3.11* (group 1 under 5 years). More than half of the trips of group two and six are short trips. For groups two, five and six, the number of trips decreases as trip length increases, but group three and four do not follow the same sequence; medium trips have the highest proportion followed by long trips and then the short trips.

| *Table 3.11*: Effect of Age on Trip Length, ( Note i- under 5 years) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Trip length category | (ii) - 5 to 14 | | (iii)-15 to 24 | | (iv)-25 to 39 | | (v)-40 to 65 | | (vi)-Over 65 | | |
| | No. | (%) | No | (%) | No. | % | No | % | No | % | Total |
| Short trips | 949 | 55% | 562 | 31% | 740 | 26% | 563 | 37% | 45 | 55% | **2859** |
| Medium rips | 462 | 27% | 634 | 35% | 1106 | 39% | 482 | 32% | 22 | 27% | **2706** |
| Long trips | 277 | 16% | 604 | 33% | 943 | 34% | 465 | 30% | 15 | 18% | **2304** |
| Sub total | **1688** | **98%** | **1800** | **99%** | **2789** | **99%** | **1510** | **99%** | **82** | **100%** | **7869** |
| External trip | 36 | 02% | 10 | 01% | 26 | 01% | 20 | 01% | 0 | 00% | **92** |
| Total | **1724** | **100%** | **1810** | **100%** | **2815** | **100%** | **1530** | **100%** | **82** | **100%** | **7961** |
| Source: Home Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to column total) | | | | | | | | | | | |

### 3.1.4 - *TRIP DURATION*

#### 3.1.4.1 - RESIDENTS PERSON TRIP DURATION

The distribution of duration of person trips made by all modes of travel within the Muscat Area is shown in *table 3.12*. Trip duration of up to 10 minutes accounts for 41.5 per cent and from 11 to 20 minutes 31.7 per cent of the total. Trips of more than 30 minutes share 10.6 per cent, while trips of between 20 and 30 minutes account for 16.2 per cent of total person trips. Considering Omani and non-Omani population some variation can be noted.

| *Table 3.12*: Trip Duration of Internal Personal Travel, 24-hour day | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Trip Duration ( minutes) | INTERNAL TRIPS | | | | EXTERNAL TRIPS | | TOTAL Person Trips | |
| | Omani | | Non-Omani | | | | | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| 0 ---- 5 | 968 | 16.4% | 271 | 13.7% | 0 | 0.0% | **1239** | **15.6%** |
| 6 ---10 | 1523 | 25.9% | 539 | 27.1% | 0 | 0.0% | **2062** | **25.9%** |
| 11-- 20 | 1731 | 29.4% | 792 | 40.0% | 5 | 5.4% | **2528** | **31.7%** |
| 21-- 30 | 999 | 17.0% | 289 | 14.6% | 4 | 4.4% | **1292** | **16.2%** |
| 31 -- 40 | 283 | 4.8% | 47 | 2.4% | 1 | 1.1% | **331** | **4.2%** |
| 41 -- 60 | 382 | 6.5% | 44 | 2.2% | 7 | 7.6% | **433** | **5.4%** |
| Over 60 | 1 | 0.0% | 0 | 0.0% | 75 | 81.5% | **76** | **1.0%** |
| Total trips | **5887** | **100%** | **1982** | **100%** | **92** | **100%** | **7961** | **100%** |
| Source: Home Interview Survey, Fieldwork 1990 (Share in % related to column total)<br>Note : Trip durations were calculated from reported times of departure and arrival. | | | | | | | | |

#### 3.1.4.2 - INBOUND TRAFFIC TRIP DURATION

*Table 3.13* shows the distribution of duration of external traffic entering the Muscat Area and ending within it by all modes of travel. About 74 per cent of the entering traffic has trip duration of more than one hour, while trip duration of less than 30 minutes accounts for only 6.9 per cent. Splitting up trip durations according to the cordon point where the traffic enters, it can be seen that traffic that enters from cordon point two has a longer duration than that entering from cordon point one. About 53 per cent of trips entering from cordon point two have a duration of more than two hours. On the other hand, around 31 per cent entering from point one have the same duration. Trips with a duration of less than one hour account for 30.4 per cent in point one and 21.1 per cent in cordon point two. This variation in trip duration reflects the distribution of the population and types of road connected to the trip generation area.

Most of the traffic entering from cordon point one (97%) is generated from areas, the majority of which are close to a dual carriageway with high speeds (120 km) and good visibility due to the carriageway alignment along the flat land of the Al-Batinah plain. On the other hand, traffic entering from point two, 99 per cent of the total is generated from areas spread over an area dominated by the mountain ridge of Al-Hajar and connected to the Muscat Area through a single road with low speeds and poor visibility due to the topography of the area.

*Table 3.13*: Duration of External Trips Entering the Muscat Area

| Trip Duration | Cordon Point 1 | | Cordon Point 2 | | Total Entered | |
|---|---|---|---|---|---|---|
| (minutes& hours) | No. | (%) | No. | (%) | No. | (%) |
| Under 15 Min | 3 | 0.8% | 6 | 1.7% | 9 | 1.2% |
| 15 to 30 Min | 34 | 8.4% | 9 | 2.5% | 43 | 5.7% |
| 30 Min to 1 hour | 85 | 21.2% | 60 | 16.9% | 145 | 19.2% |
| 1 to 2 hour | 154 | 38.4% | 92 | 25.9% | 246 | 32.5% |
| 2 to 3 hour | 76 | 19.0% | 89 | 25.1% | 165 | 21.8% |
| over 3 hour | 49 | 12.2% | 99 | 27.9% | 148 | 19.6% |
| Total trips | 401 | 100% | 355 | 100% | 756 | 100% |

Source: Roadside Interview, Fieldwork Muscat 1990

## 3.2 : HOW PEOPLE TRAVEL

### 3.2.1 - *GENERAL*

The decision of an individual to choose a particular mode of travel is influenced by several factors. These include the options available and their relative merits and disadvantages for certain people making particular types of trips, whilst for others it may be a result of limited alternatives. The alternatives open to an individual depend on car availability and ability to drive, or the existence of suitable public transport services at the time planned for the trip. Trip length and duration are usually taken into consideration, as well as the inconvenience and possible difficulty associated with parking a vehicle. The relative cost of different modes is more important for people on a low income and long trip length, while the more affluent may make a decision on the grounds of convenience, pleasantness of the travel experience, image, and perception of personal safety(3).

### 3.2.2 - *RESIDENTS' MODE OF PERSONAL TRAVEL*

The modes of daily personal travel made by the residents of the Muscat Area are shown in *table 3.14.* Private vehicles emerge as the dominant mode of travel, of all person trips, roughly 59 per cent are made by private vehicles. Over 21 per cent of all trips made are on foot. Private bus trips account for 11 per cent of all trips; cycle trips are relatively few in number. Travel by public transport accounts for nearly 5 per cent of all person trips within the Study Area.

*Table 3.14* : Mode of Personal Travel by Omani and Non-Omani

| Basic Mode Classification | Internal Trips | | | | | | External Trips | | Residents Total Trips | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Omani | | Non-Omani | | Total(internal) | | | | | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| 1 - Walk | 1514 | 25.7% | 206 | 10.3% | 1720 | 21.9% | 0 | 0.0% | 1720 | 21.5% |
| 2 - Pedal Cycle | 83 | 1.4% | 19 | 1.0% | 102 | 1.3% | 0 | 0.0% | 102 | 1.3% |
| 3 - Motor Cycle | 2 | 0.1% | 7 | 0.4% | 9 | 0.1% | 0 | 0.0% | 9 | 0.1% |
| 4 -Private Vehicle | 3166 | 53.8% | 1416 | 71.4% | 4582 | 58.2% | 74 | 80.4% | 4656 | 58.5% |
| 5 - Taxi | 103 | 1.7% | 45 | 2.3% | 148 | 1.9% | 0 | 0.0% | 148 | 1.9% |
| 6 - Pick-up Taxi | 128 | 2.2% | 11 | 0.6% | 139 | 1.8% | 12 | 13.0% | 151 | 2.0% |
| 7 - L. C. Vehicle | 120 | 2.0% | 83 | 4.2% | 203 | 2.6% | 2 | 2.2% | 205 | 2.6% |
| 8 - H. C. Vehicle | 0 | 0.0% | 2 | 0.1% | 2 | 0.0% | 0 | 0.0% | 2 | 0.0% |
| 9 - ONTC Bus | 52 | 0.9% | 30 | 1.5% | 82 | 1.0% | 0 | 0.0% | 82 | 1.0% |
| 10 - Private Bus | 719 | 12.2% | 163 | 8.2% | 882 | 11.2% | 4 | 4.4% | 886 | 11.1% |
| Total trips | 5887 | 100% | 1982 | 100% | 7869 | 100% | 92 | 100% | 7961 | 100% |

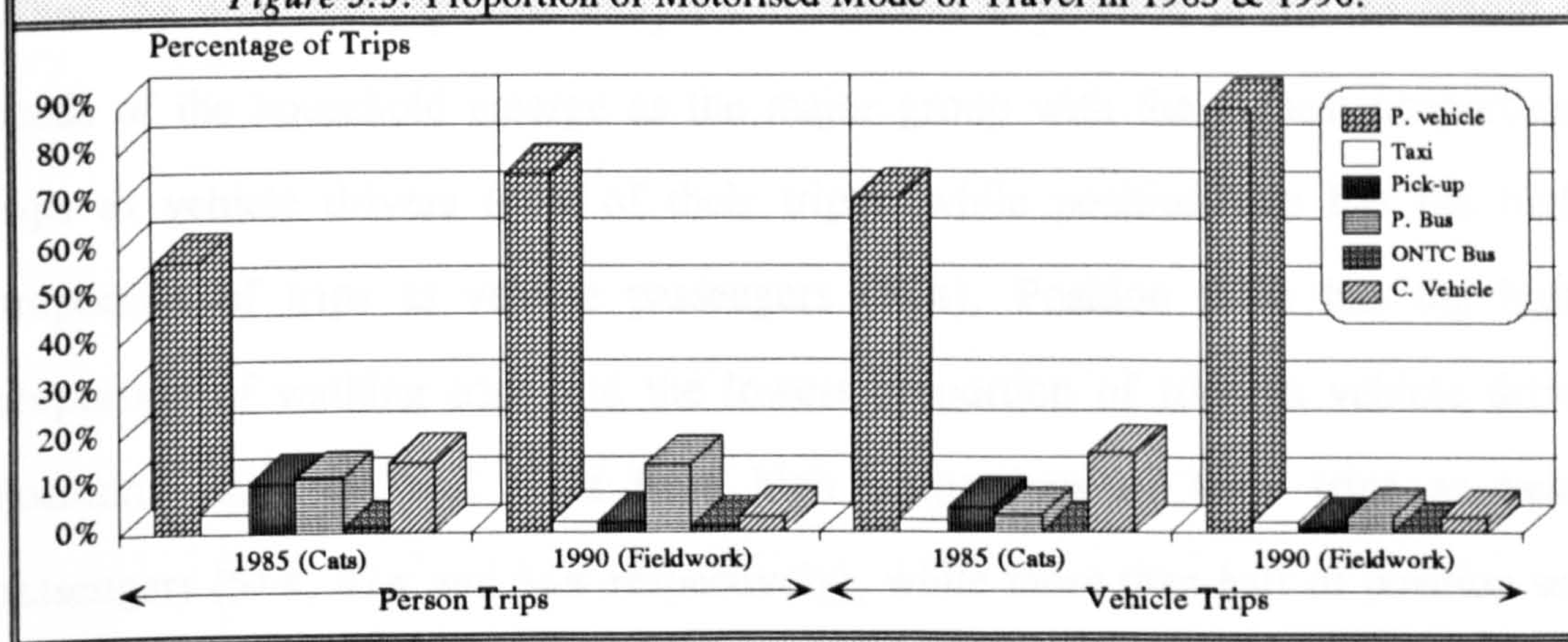
Source: Home Interview Survey, Fieldwork , Muscat 1990 ( share in % related to column total)

When modes of personal travel are considered in terms of Omani and non-Omani people, a clear picture emerges of non-Omani as the people with high proportion of their trips made by private vehicles. Over 71 per cent of all non-Omani trips are made by this mode, compared with 53.8 per cent of all Omani trips made by private vehicles. The proportions of walking trips appear to be higher with the Omani than non-Omani.

### 3.2.2.1 - COMPARISON OF VEHICULAR TRAVEL IN 1985 & 1990

*Figure 3.3* illustrates the comparison of the results of the 1985 Roadside Interview and 1990 Home Interview Survey on the basis of motorised mode of travel. As seen previously, the motorised trips account for 77.2 per cent of all person trips within the Study Area in 1990. Private vehicles have clearly become the principal mode of travel in the Muscat Area, accounting for 57.6 per cent in 1985 and 76.0 per cent in 1990 of total motorised trips. The significance of the private vehicle is strengthened in terms of vehicle trips as it accounts for 70.8 per cent in 1985 and 89.7 per cent in 1990 of all vehicle trips. This increase in proportion of people using private vehicles as a mode of travel over the past five years confirms that it will continue to be the main mode of travel in the future. The proportion of people using other modes of travel has slightly decreased over the last period with the exception of two modes ( private bus, ONTC bus). The slight increase in the proportion of public transport bus (ONTC) usage may be attributable not only to the decrease in the usage of the passenger pick-up, but also to changes in peoples' attitudes towards the use of the ONTC buses.

*Figure 3.3*: Proportion of Motorised Mode of Travel in 1985 & 1990.




Source: 1 - Capital Area Transport Study 1985, 2- Home Interview Survey, fieldwork 1990

This study reveals that the occupancy of private vehicles is low compared to other passenger carrying vehicles. Similar conclusions were drawn from the Capital Area Transport Study findings in 1985. Private vehicles account for 58 per cent and 76 per cent of all travel demand but for 71 per cent and 90 per cent of all vehicle trips in 1985 and 1990 respectively. The ratio of private vehicle passengers to private vehicle drivers is 0.54, (i.e. the average occupancy of private vehicles on internal trips is 1.54 person). Other passenger vehicles (taxis, passenger pick-ups, private buses and ONTC bus) met 28 per cent of all travel demand but accounted for only 12 per cent of all vehicular traffic in 1985, while in 1990 it met 21 per cent of all travel but accounted for 7 per cent of all vehicular traffic. These differences reflect the increase in private vehicle availability per household (Chapter 2), and the tendency towards the use of ONTC buses over the past five years, compared to other modes of public transport.

The Home Interview excluded people living in bachelor accommodation dormitories and labour camps, where the high proportion of construction labourers live. These groups of people have a great impact particularly on the proportion of person trips made by commercial vehicles. The low proportions of trips made by commercial vehicles either in terms of the total travel demand or vehicular movements in 1990 were mainly due to the above reason.

3.2.2.2 - PERSON POSITION AND MODE OF TRAVEL

When the recorded trips are analysed in relation to position in the household, the heads of the household emerge as the major group with the highest proportion of trips as vehicle drivers (66% of their trips), while position two has the highest proportion of trips as vehicle passengers (55%). Position three has the highest proportion of walking trips and the lowest proportion of trips as vehicle drivers. Positions four, six and eight have high proportions of their trips as vehicle passengers (54%, 42% and 54% respectively), while more than half of position seven (servant) trips are on foot.

*Table 3.15* shows the proportion of motorised and unmotorised trips in terms of position in the household for the Omani and non-Omani population. It can be seen that there is a significant variation between Omani and non-Omani population, particularly in the head-of-the-household trips where more than 90 per cent of non-Omani trips are made by persons driving a vehicle compared to 54 per cent for

Omani. These variations reflect the characteristics of Omani and non-Omani households.

*Table 3.15* :Distribution of Trips According to Person Position and Mode of Travel

| Person Position in the Household | Omani Population | | | | | | Non-Omani Population | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Motorised Trips | | | | Unmotorised Trips | | Motorised Trips | | | | Unmotorised Trips | |
| | Driver | | Passenger | | | | Driver | | Passenger | | | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| 1-Head of hous'd | 1078 | 54.1 % | 503 | 25.3 % | 410 | 20.6 % | 807 | 90.4 % | 44 | 4.9 % | 42 | 4.7 % |
| 2-Husband, wife | 161 | 26.3 % | 333 | 54.4 % | 118 | 19.3 % | 122 | 33.8 % | 202 | 56.0 % | 37 | 10.2 % |
| 3-Furth. mother | 2 | 2.1% | 35 | 37.3 % | 57 | 60.6 % | 0 | 0.0 % | 2 | 100 % | 0 | 0.0 % |
| 4-Son, Daughter | 515 | 19.6% | 1261 | 48.0 % | 853 | 32.4 % | 6 | 1.3 % | 402 | 87.7 % | 50 | 11.0 % |
| 5-Brother, Sister | 124 | 45.1 % | 90 | 32.7% | 61 | 22.2 % | 15 | 36.6 % | 21 | 51.2 % | 5 | 12.2 % |
| 6-Other relatives | 83 | 30.1 % | 125 | 45.3 % | 68 | 24.6 % | 21 | 36.2% | 15 | 25.9 % | 22 | 37.9 % |
| 7- Servant | 00 | 0.0 % | 00 | 0.0 % | 00 | 0.0 % | 44 | 26.5 % | 35 | 21.1% | 87 | 52.4 % |
| 8- Friend | 36 | 41.4 % | 46 | 52.9 % | 5 | 5.7 % | 00 | 0.0 % | 12 | 63.2 % | 7 | 36.8 % |
| Total | 1999 | 33.5 % | 2393 | 40.1% | 1572 | 26.4 % | 1015 | 50.8 % | 733 | 36.7 % | 250 | 12.8 % |

Source: Home Interview Survey, Fieldwork, Muscat 1990. (Share in % related to row total)

### 3.2.2.3 - AGE, SEX AND MODE OF TRAVEL

When the total trips are split into motorised and unmotorised trips according to age group, people in the 25 to 39 age group appear to have the highest percentage of their trips as vehicle drivers (59%), followed by the 40 to 65 age group (53%), while the youngest group (5 to 14 year) have the highest proportion of their trips as vehicle passengers, reflecting their ability to drive. The group with the highest share of unmotorised trips is the oldest in which over half of their trips are on foot.

Different results emerge when male and female trips are separated. As discussed earlier (Chapter 2), 51 per cent of the population is male and 49 per cent is female. This proportion varies significantly in terms of the total trips made between males and females; 73 per cent of the total trips are made by males while the remaining 27 per cent are made by females. This significant variation reflects the high proportion of unemployed females(housewives). In addition, cultural traditions along with the hot climate do not encourage them to do outdoor activities, (e.g. family shopping).

The predominant mode of travel used by females is the family car and mostly as passengers. This is evident from the percentage of males and females holding driving licence in the households surveyed, where 82 per cent of males hold a full driving licence compared with 18 per cent for females. *Table 3.16* shows about 62.6 per cent of total female trips as passengers, 18.1 per cent as drivers and walking trips account for 19.3 per cent. The role of public transport in the female movements is insignificant, particularly the ordinary taxis. For example, it is unusual for a female to hail a taxi on her own because many people would consider this unacceptable since she would be travelling alone with a complete stranger. On the other hand, the image of ONTC buses deters females from using them as alternative mode of travel as they have to wait in the hot weather and it is an uncomfortable ride due to the high proportion of male passengers who are mostly foreign labourers.

*Table 3.16* shows the proportion of male and female trips according to age group and mode of travel. Males in the age groups of 25 to 39 and 40 to 65 emerged as the males with highest proportion of their trips as vehicle drivers, while the groups 5 to 14 and 15 to 24 have the highest proportion of their trips as vehicle passengers. The oldest male group (over 65) appear with the highest proportion of unmotorised trips. The proportion of female trips as vehicle passengers is the highest in all the age groups.

*Table 3.16*: Distribution of Trips According to Person Age and Mode of Travel

| Person Age Group ( Years) | Male | | | | | | Female | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Motorised Trips | | | | Unmotorised Trips | | Motorised Trips | | | | Unmotorised Trips | |
| | Driver | | Passenger | | | | Driver | | Passenger | | | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| 5 -- 14 | 0 | 0.0% | 570 | 52.9% | 507 | 47.1% | 0 | 0.0% | 481 | 74.4% | 166 | 25.6% |
| 15 - 24 | 475 | 36.8% | 538 | 41.7% | 277 | 21.5% | 67 | 12.9% | 375 | 72.1% | 78 | 15.0% |
| 25 - 39 | 1379 | 67.1% | 398 | 19.3% | 280 | 13.6% | 273 | 36.0% | 384 | 50.7% | 101 | 13.3% |
| 40 - 65 | 757 | 57.6% | 256 | 19.5% | 302 | 22.9% | 48 | 22.3% | 100 | 46.5% | 67 | 31.2% |
| over 65 | 15 | 20.5% | 18 | 24.7% | 40 | 54.8% | 0 | 0.0% | 5 | 55.6% | 4 | 44.4% |
| Total | 2626 | 45.2% | 1780 | 30.6% | 1406 | 24.2% | 388 | 18.1% | 1345 | 62.6% | 416 | 19.3% |

Source: Home Interview Survey, Fieldwork, Muscat 1990. (Share in % related to row total)

### 3.2.3 - *INBOUND TRAFFIC BY MODE OF TRAVEL*

During the 12 hour period of vehicle classification count at each one of the two cordon points, about 7282 vehicles entered the Muscat Area boundary. Of all vehicles, 52.2 per cent were private vehicles, 20.2 per cent pick-ups and 27.6 per cent were other types of vehicles as seen in *table 3.17.* This high share of pick-up movements along the Study Area boundary reflects the dominating role of the pick-ups as the main mode of public transport between the Muscat Area and the rest of the country, which is also evident from average vehicle occupancy and number of trips per day per vehicle as will be seen later.

*Table 3.17*: Inbound Traffic by Vehicle Type

| Basic Classification | Total Interviewed Vehicles | | | | | | | | | | Actual Inbound Traffic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Trips End within the Muscat Area | | | | | | Through Trips | | Total Traffic | | | |
| | Cordon 1 | | Cordon 2 | | Total Entered | | | | | | | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| P. Vehicle | 246 | 61.3% | 228 | 64.3% | 474 | 62.7% | 32 | 57.1% | 506 | 62.3% | 3796 | 52.2% |
| Taxi | 22 | 5.5% | 37 | 10.4% | 59 | 7.8% | 4 | 7.1% | 63 | 7.7% | 539 | 7.4% |
| Pick-up | 83 | 20.7% | 53 | 14.9% | 136 | 18.0% | 8 | 14.3% | 144 | 17.7% | 1468 | 20.2% |
| L. C. Veh. | 31 | 7.7% | 26 | 7.3% | 57 | 7.5% | 11 | 19.6% | 69 | 8.5% | 586 | 8.0% |
| H.C. Veh. | 1 | 0.3% | 0 | 0.0% | 1 | 0.1% | 1 | 1.9% | 2 | 0.3% | 459 | 6.3% |
| P. Bus | 18 | 4.5% | 11 | 3.1% | 29 | 3.9% | 0 | 0.0% | 28 | 3.5% | 380 | 5.2% |
| ONTC Bus | --- | ---- | --- | ---- | --- | ---- | --- | ---- | --- | ---- | 47 | 0.6% |
| M. Cycle | --- | ---- | --- | ---- | --- | ---- | --- | ---- | --- | ---- | 7 | 0.1% |
| Total trips | 401 | 100% | 355 | 100% | 756 | 100% | 56 | 100% | 812 | 100% | 7282 | 100% |

Source : Roadside Interview and Vehicle Classification Count Surveys, Fieldwork, Muscat 1990

### 3.2.3.1 - VEHICLE OCCUPANCY

Average vehicle occupancy varies with vehicle type, (*table 3.18*). Pick-ups have the highest occupancy rate, while private vehicles have the lowest. The high occupancy of pick-ups reflects their trip purpose, where most of the pick-ups trips were found to be serving passengers. The analysis reveals that average private vehicle occupancy in the external trips is higher than in the internal trips. Slightly similar average vehicle occupancy for each vehicle appears when the cordon points are separated *(Table 3.18*).

*Table 3.18* Average Vehicle Occupancy per Mode of Travel

| Basic Vehicle Classification | Cordon Point One | | | Cordon Point Two | | |
|---|---|---|---|---|---|---|
| | No. of Passengers | | Vehicle Occupancy | No. of Passengers | | Vehicle Occupancy |
| | Omani | None | | Omani | None | |
| Private Vehicle | 274 | 101 | 2.45 | 351 | 79 | 2.78 |
| Taxi | 41 | 27 | 3.83 | 100 | 14 | 3.92 |
| Pick-up Taxi | 260 | 88 | 5.10 | 188 | 27 | 4.84 |
| L. C. Vehicle | 12 | 21 | 1.97 | 29 | 27 | 2.93 |
| Private Bus | 48 | 26 | 4.7 | 12 | 9 | 3.3 |

Source: Roadside Interview Survey, Fieldwork, Muscat 1990

### 3.2.3.2 - TRAVEL MODE AND FREQUENCY OF TRAVEL

During the Roadside Interview, vehicle drivers were asked how often they travel along that section of the road. If the answer was frequently, then they were asked to state the average number of trips per day. Out of the 812 vehicles which entered the Muscat Area boundary 444 vehicles (54.7%) were travelling frequently. Therefore this proportion reflects the regularity of more than half of the traffic movements along the Study Area boundary.

When this information is seen in terms of mode of travel used for the trips, private vehicles are the dominant mode in terms of total number of vehicles and their existence in all frequency groups, but they are less (49%) in the case of the more frequently used mode of travel. Taxis and pick-ups emerge as the most frequently used modes of travel, more than 68 per cent of interviewed taxi drivers and nearly 68 per cent of the pick-up drivers are frequent travellers.

*Table 3.19* shows the relationship between mode of travel and frequency of trips per day. Pick-ups emerge with the highest proportion than any mode of travel in the groups of six or more trips per day. A very high proportion of private vehicles have two trips per day and this proportion decreases as number of trips per day increases. The frequency of taxi trips per day varies from a very high proportion of taxis having two trips per day to a low proportion of taxis with maximum four trips per day. When the cordon points are separated, there are different patterns of relationship between mode of travel and frequency of trips per day, (*Table 3.19*).

*Table 3.19*: Frequency of Trips per Day by Mode of Travel Entering Muscat Boundary

| Frequency of Trips/Day | Cordon Point One | | | | Cordon Point Two | | | |
|---|---|---|---|---|---|---|---|---|
| | P. Veh. | Taxi | Pick-up | Others | P. Veh. | Taxi | Pick-up | Others |
| 2 trips/day | 74.1% | 88.9% | 45.5% | 82.1% | 83.5% | 84.0% | 67.7% | 88.2% |
| 4 trips/day | 14.4% | 11.1% | 30.3% | 15.4% | 13.8% | 16.0% | 16.1% | 11.8% |
| 6 trips/day | 10.1% | 0.0% | 19.7% | 2.5% | 1.8% | 0.0% | 9.7% | 0.0% |
| >6 trips/day | 1.4% | 0.0% | 4.5% | 0.0% | 0.9% | 0.0% | 6.5% | 0.0% |
| *Percentage* | *100%* | *100%* | *100%* | *100%* | *100%* | *100%* | *100%* | *100%* |
| Total Vehicles | 139 | 18 | 66 | 39 | 109 | 25 | 31 | 17 |

Source: Roadside Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to column total)

### 3.2.4 - *RESIDENTS TRIP LENGTH AND MODE OF TRAVEL*

The distance people are willing to travel depends on the purpose of the trip and mode of travel selected. It can be seen from *table 3.20* that 96.2 per cent of walking trips are short because intra-zonal trips are very short in nature. The majority of person trips made by private vehicles are medium and long trips, where 41.3 per cent occur between the traffic zones and 38.6 per cent between the municipalities. Trips with one end outside the Muscat Area account for 1.6 per cent of the total trips. It is evident from the table that taxis are more commonly used during people movements between the traffic zones (73.6%), while movements between the municipalities account for 19.6 per cent. The intra-zonal movements of all taxi trips account for 6.8 per cent.

*Table 3.20*: Trip length Classification by Mode of Travel

| Basic Mode of Travel Classification | <---------- Internal Trips ----------> Short Trips | | Medium Trip | | Long Trips | | External Trips | | Residents Total Trips | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| 1 - Walk | 1654 | 96.2% | 66 | 3.8% | 0 | 0.0% | 0 | 0.0% | 1720 | 100% |
| 2 - Pedal Cycle | 76 | 74.5% | 26 | 25.4% | 0 | 0.0% | 0 | 0.0% | 102 | 100% |
| 3 - Motor Cycle | 0 | 0% | 7 | 77.8% | 2 | 22.2% | 0 | 0.0% | 9 | 100% |
| 4 -Private Vehicle | 861 | 18.5% | 1927 | 41.3% | 1794 | 38.6% | 74 | 1.6% | 4656 | 100% |
| 5 - Taxi | 10 | 6.8% | 109 | 73.6% | 29 | 19.6% | 0 | 0.0% | 148 | 100% |
| 6 - Pick-up Taxi | 1 | 0.7% | 64 | 42.4% | 74 | 49.0% | 12 | 7.9% | 151 | 100% |
| 7 - L. C. Vehicle | 23 | 11.2% | 115 | 56.1% | 65 | 31.7% | 2 | 1.0% | 205 | 100% |
| 8 - H. L. Vehicle | 0 | 0.0% | 2 | 100% | 0 | 0.0% | 0 | 0.0% | 2 | 100% |
| 9 - ONTC Bus | 4 | 4.9% | 41 | 50.0% | 37 | 45.1% | 0 | 0.0% | 82 | 100% |
| 10 - Private Bus | 230 | 26.0% | 349 | 39.4% | 303 | 34.2% | 4 | 0.4% | 886 | 100% |
| Total trips | 2859 | 35.9% | 2706 | 34.0% | 2304 | 28.9% | 92 | 1.2% | 7961 | 100% |

Source: Home Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to row total)

Compared with other modes of public transport (taxis & ONTC buses) pick-ups emerge as the mode with the high proportion of long trips. More than half of the trips made by pick-ups are either long or external trips. Oman National Transport Company (ONTC) buses are more frequently used in movements between the traffic zones and between the municipalities.

### 3.2.5 - *MODE OF TRAVEL AND TRIP DURATION*

#### 3.2.5.1 - RESIDENTS' TRIP DURATION

The duration of person trips made by various modes of travel is illustrated in *table 3.21*. In all cases, the shorter trips of up to 10 minutes are dominated by unmotorised trips and private vehicle use (83% unmotorised and 33.3% private vehicle overall). A higher proportion of public transport trips is found in the 11 to 30 minutes time band than in the trips lasting less than 11 minutes or higher than 30 minutes. In the case of the trips made by private vehicles, roughly two-third of the trips are found in the 6 to 20 minutes time band, while the trips lasting more than 20 minutes make up less than one-third of the total trips. For the trips of over one hour private vehicles are found to be the dominant mode of travel, while trips of less than 10 minutes are dominated by unmotorised trips (walking & cycling).

*Table 3.21*: Trip Duration of Personal Travel by Travel Mode

| Trip Duration ( Minutes) | Unmotorised Trips | | Private Vehicle | | Public Transport | | Other Modes | | All Modes | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| 0 - 5 | 736 | 40.4% | 438 | 9.4% | 20 | 5.2% | 45 | 4.1% | 1239 | 15.6% |
| 6 - 10 | 776 | 42.6% | 1115 | 23.9% | 43 | 11.3% | 128 | 11.6% | 2062 | 25.9% |
| 11 - 20 | 257 | 14.1% | 1771 | 38.1% | 118 | 31.0% | 382 | 34.6% | 2528 | 31.7% |
| 21 - 30 | 53 | 2.9% | 792 | 17.0% | 92 | 24.1% | 355 | 32.2% | 1292 | 16.2% |
| 31 - 40 | 0 | 0.0% | 214 | 4.6% | 40 | 10.5% | 77 | 7.0% | 331 | 4.2% |
| 41 - 60 | 0 | 0.0% | 256 | 5.5% | 64 | 16.8% | 113 | 10.3% | 433 | 5.4% |
| Over 60 | 0 | 0.0% | 70 | 1.5% | 4 | 1.1% | 2 | 0.2% | 76 | 1.0% |
| Total trips | 1822 | 100% | 4656 | 100% | 381 | 100% | 1102 | 100% | 7961 | 100% |

Source: Home Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to column total)

#### 3.2.5.2 - INBOUND TRAFFIC TRIP DURATION

When the trip duration of the external traffic is seen in terms of travel mode, a high proportion of public transport trips take over one hour (81%). In the case of trips made by private vehicles, 71 per cent take over one hour, while trips made by others mode of travel (commercial vehicles & private buses) for the same duration account for 70 per cent. Trips within the 1 to 2 hour time band emerge as the highest proportion of trips in all modes of travel, while the trips lasting less than 15 minutes have the lowest proportion. In all cases of trip duration categories, private vehicles appear as the dominant used mode of travel.

*Table 3.22* shows the trip duration of external traffic entering the Muscat Area boundary and ending within it from each cordon point for the different modes of travel. When the external trips are separated according to the cordon point of where the traffic entered, there is a significant variation, particularly in terms of the proportion of trips with long duration, and especially in the proportion of the trips lasting over three hours.

*Table 3.22:* Duration of External Trips by Mode of Travel

| Trip Duration ( Minutes & Hours) | Cordon Point One | | | | | | Cordon Point Two | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Private Vehicle | | Public Transport | | Other Modes | | Private Vehicle | | Public Transport | | Other Modes | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| Under 15 Min | 0 | 0.0% | 2 | 1.9% | 1 | 2.0% | 5 | 2.2% | 1 | 1.1% | 0 | 0.0% |
| 15 to 30 Min | 24 | 9.7% | 5 | 4.8% | 5 | 10.0% | 4 | 1.7% | 2 | 2.2% | 3 | 8.1% |
| 30 Min to 1 hr | 57 | 23.2% | 15 | 14.2% | 13 | 26.0% | 44 | 19.3% | 12 | 13.3% | 4 | 10.8% |
| 1 to 2 hr | 85 | 34.6% | 51 | 48.6% | 18 | 36.0% | 64 | 28.1% | 23 | 25.6% | 5 | 13.5% |
| 2 to 3 hr | 48 | 19.5% | 21 | 20.0% | 7 | 14.0% | 57 | 25.0% | 26 | 28.9% | 6 | 16.2% |
| over 3 hr | 32 | 13.0% | 11 | 10.5% | 6 | 12.0% | 54 | 23.7% | 26 | 28.9% | 19 | 51.4% |
| Total trips | 246 | 100 % | 105 | 100% | 50 | 100% | 228 | 100% | 90 | 100% | 37 | 100% |

Source: Roadside Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to column total)

## 3.3 - WHY PEOPLE TRAVEL

### 3.3.1 - *TRIP PURPOSE DEFINITIONS*

Trip purpose was defined generally as the reason for which a trip is made, the fulfilment of which marks the end of the trip. In order to distinguish between origin and destination purpose, the purpose of a trip is defined in three distinct ways, each of which has a place in developing an understanding of the travel pattern:-

(1) Origin Purpose: Purpose of the trip as defined by what the traveller was doing at the origin end of his trip, (e.g., leaving home).

(2) Destination Purpose: Purpose of the trip as defined by what the traveller was doing at his destination, (e.g., going to work or to school).

(3) Basic Purpose: Purpose as defined by the basic reason for which the trip was being made.

A basic purpose may not always be a destination purpose. For example a trip from home to work and a trip from work to home can both be ascribed primarily to the trip-maker's working activity and therefore described as a work trip. For the analysis in this study the basic trip purposes were grouped into three categories: -

(i) Home-based work trip ( work): A trip from home to work and from work to home.

(ii) Other home-based trips (OHB): A trip from/to home, to/from education, shopping, recreation, personal business, etc.

(iii) Non-home-based trips(NHB): A trip which has home neither as an origin nor as a destination.

For the purpose of this study the destination purpose of all trips, other than those to home, are considered as the basic purpose of the trip. The basic purpose of a homeward trip is considered to be the same as the origin purpose.

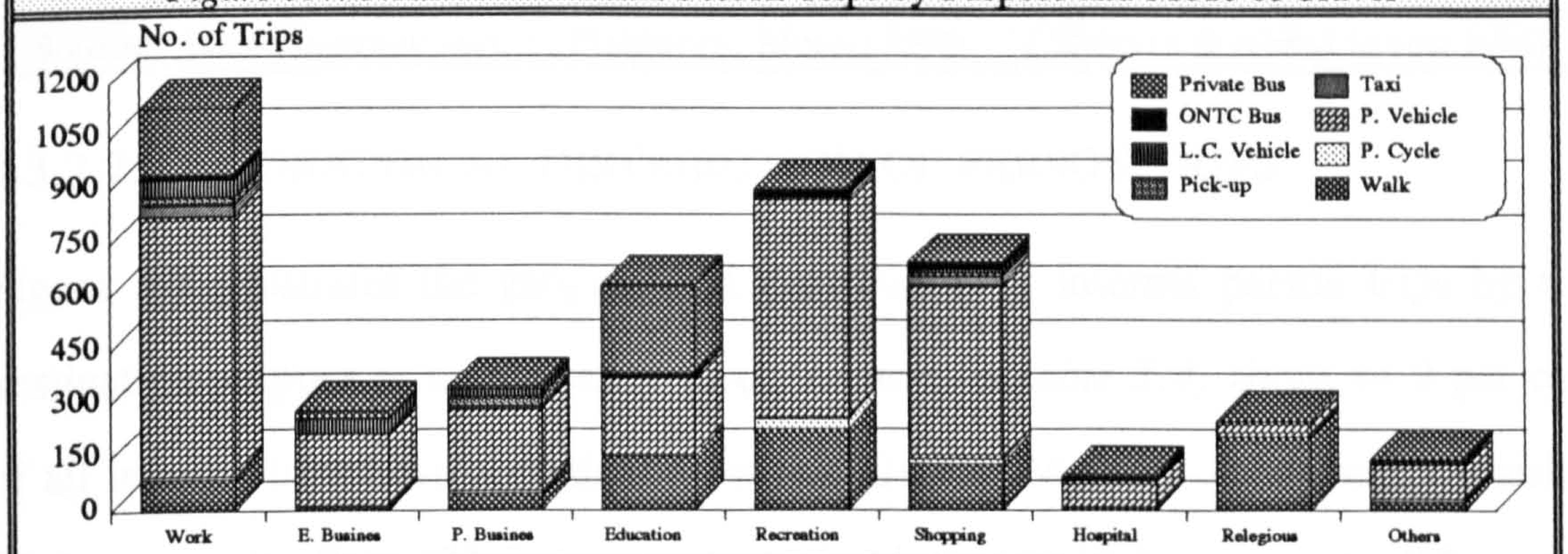
### 3.3.2.: DESTINATION PURPOSE OF INTERNAL TRAVEL

In the recording of household interview data, ten trip purpose categories were used. These were: (1) home; (2) work; (3) employer's business; (4) personal business; (5) education; (6) recreation; (7) shopping; (8) hospital; (9) religious; and (10) others. The fulfilment of any one of these purposes marked the end of a trip.

A total of 7961 trips was recorded in the households surveyed in the Muscat Area. The analysis reveals that the dominant trip purpose of persons is to home; 43.6 per cent of all person trips are made for this purpose. Work trips make up 14.3 per cent of all person trips, recreation account for 11.3 per cent and shopping 8.7 per cent of all person trips. Education trips make up 7.9 per cent of all person trips, this low proportion of education trips is due to the fact that the Home Interview Survey was conducted during a period where a high proportion of schools were already closed for the summer holidays, ( see also Appendix "A").

*Figure 3.4* shows the relationships between basic trip purposes and main modes of travel. The survey findings confirm that, as in other large urban area studies, work represents the motive for a large proportion of trips (about 25.4 per cent of all basic trips). The dominant mode for work trips is private vehicle which accounts for 64.1 per cent of all work trips, followed by private bus 16.6 per cent, walking 7.9 per cent and light commercial vehicle 4.9 per cent. Education trips account for 14.0 per cent of the basic trips total, the main mode for education is private bus which accounts for 39.3 per cent, followed by private vehicle 34.2 per cent and 24.5 per cent of all education trips are made on foot. For recreation, shopping, hospital, employer's and personal business trips, private vehicle is the major mode; 68 per cent for recreation, 69 per cent for shopping, 73 per cent for employer's business and 70 per cent of personal business trips are made by private vehicle. Pedestrian movement reaches its peak in religious trips, about 83 per cent of all religious trips are on foot.

*Figure 3.4*: Number of Internal Person Trips by Purpose and Mode of Travel




Source: Home Interview Survey, Fieldwork, Muscat 1990.

3.3.2.1: BASIC PURPOSE AND HOME LINKAGE

Over 87 per cent of all basic internal trips made by the residents of the households surveyed are home-based, thus emphasising the strong influence of home locations on the travel pattern. The proportion of home-based travel varies with purpose: 91 per cent for work travel down to 86 per cent for all other purposes. Home-based work trips account for 23.7 per cent of all basic internal trips. About 91.6 per cent of these involve travel by motorised means of transport which are mainly made by vehicle drivers (69%). Home-based Other trips make up 63.6 per cent of all basic trips, nearly 70 per cent of these are made by motorised modes of travel in which 38 per cent are made by vehicle drivers. Non-home-based trips account for 12.8 per cent of all basic internal trips. A high proportion of these involve travel for employer's business and personal business, largely performed by vehicle drivers, while the lower proportion involves various work/shopping/recreation/religious combinations, which are relatively short in nature. *Table 3.23* shows the relationship between basic trip purpose and home linkage of internal travel by mode of travel.

*Table 3.23*: Basic Purpose and Home Linkage of Internal Travel

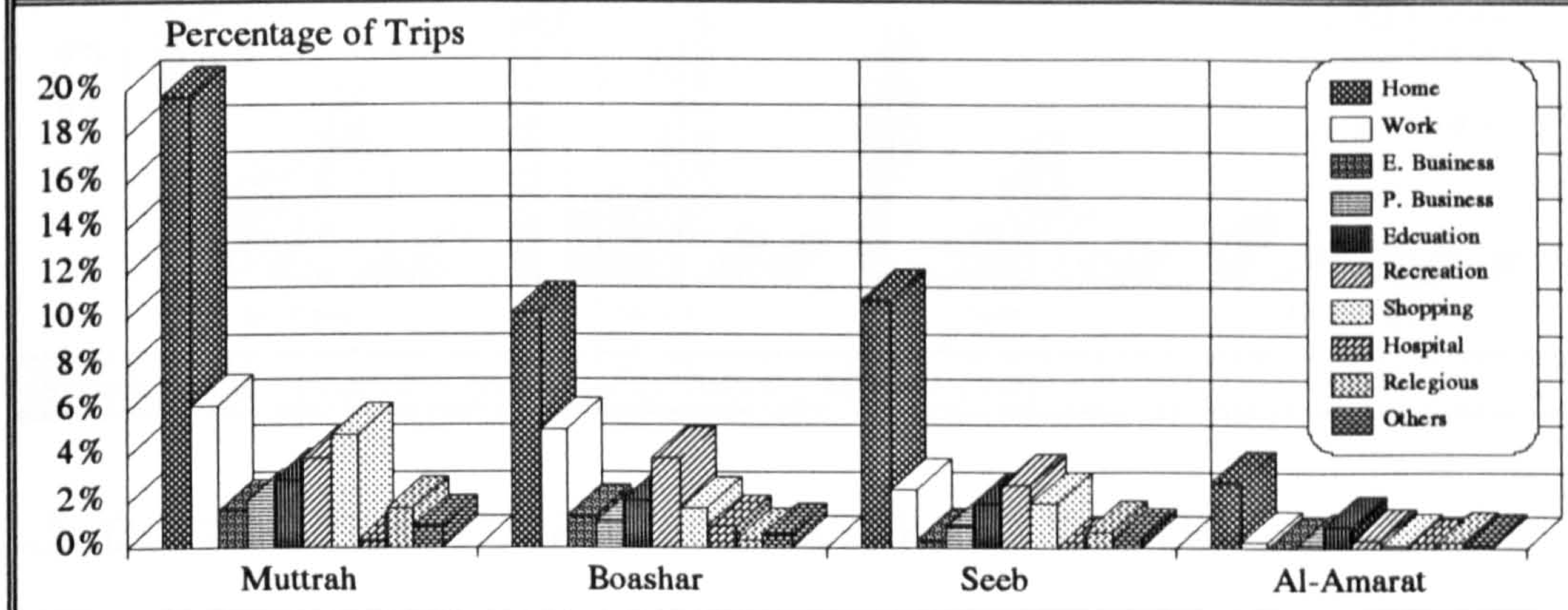
| Basic trip Purpose | Motorised Trips | | | | Unmotorised Trips | | All Modes | |
|---|---|---|---|---|---|---|---|---|
| | Driver | | Passenger | | | | | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| Home-base Work | 1194 | 63.5% | 530 | 28.1% | 159 | 8.4% | 1883 | 100% |
| Home-base Others | 1321 | 26.1% | 2185 | 43.3% | 1555 | 30.7% | 5061 | 100% |
| Non-Home Base | 499 | 49.1% | 410 | 40.3% | 108 | 10.6% | 1017 | 100% |
| Total | 3014 | 37.9% | 3125 | 39.2% | 1822 | 22.9% | 7961 | 100% |

Source: Home Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to row total)

### 3.3.2.2: GEOGRAPHICAL DISTRIBUTION OF PERSON TRIPS

*Figure 3.5* illustrates the geographical distribution of internal person trips by trip destination purpose at municipality level. As seen in *table 3.4,* about 44.9 per cent of all internal trips have a destination within Greater Muttrah; followed by Boashar 27.4 per cent; Seeb 22.6 per cent; and Al-Amarat 5.1 per cent. When trip destination is considered in terms of trip purpose, Greater Muttrah has the highest proportion of trip purpose destination in all cases, except person trips made for hospital and recreation purposes in which Boashar is the highest. Regarding places that attract trips to home, Muttrah accounts for 19.8 of all internal trips, Boashar 10.2 per cent, Seeb 10.9 per cent and Al-Amarat 2.9 per cent. About 44 per cent of all work trips are attracted to Muttrah, while Boashar attracts 36 per cent, Seeb 18 per cent and Al-Amarat 2 per cent. Nearly three-quarters of all trips made for hospital purpose and over 36 per cent of all recreation trips have a destination within Boashar, reflecting the location of 45 per cent of all land occupied by facilities and utilities in this municipality, (chapter 2). Due to the fact that greater Muttrah is the major commercial and service centre of the Muscat Area, nearly 60 per cent of all shopping person trips have a destination within this municipality.

*Figure 3.5:* Geographical Distribution of Internal Person Trips by Destination Purpose

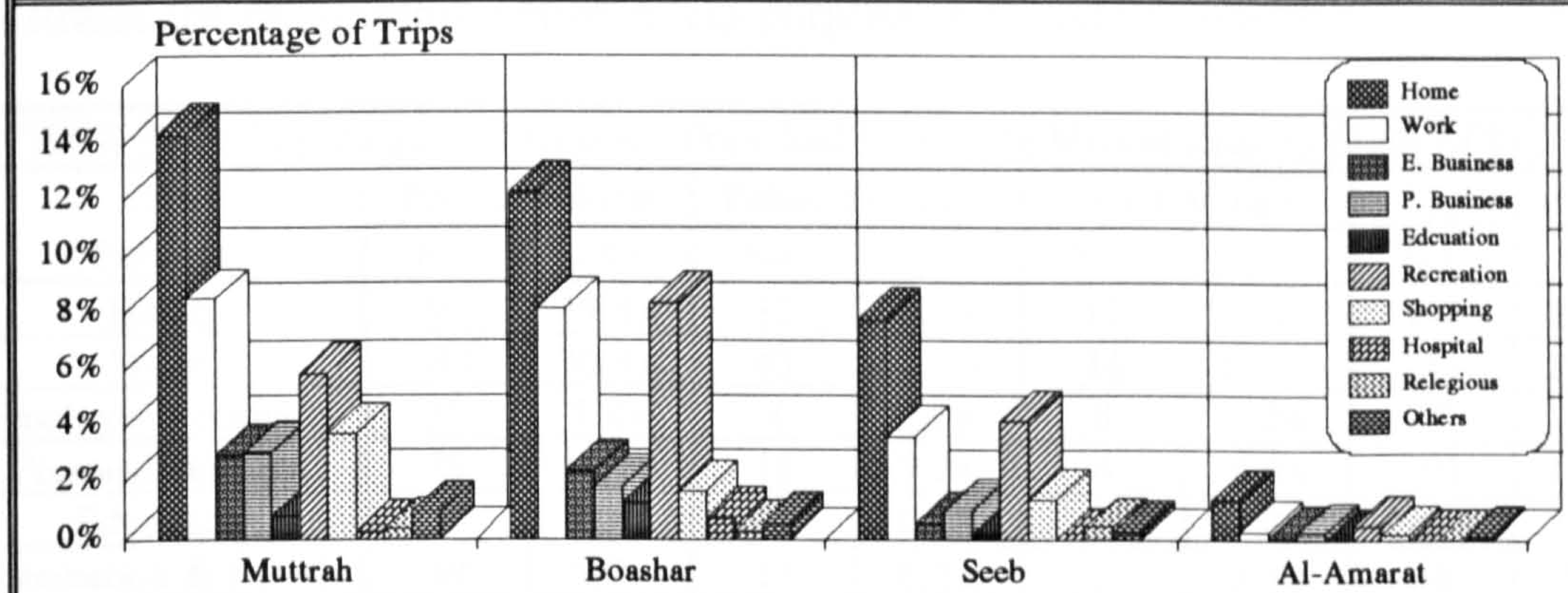



Source: Home Interview Survey, Fieldwork, Muscat 1990.

## 3.3.2.3: GEOGRAPHICAL DISTRIBUTION OF VEHICLE TRIPS

The geographical distribution of vehicular trips by destination purpose is shown in *figure 3.6*. Comparison between total vehicle trips and total person trips in terms of their percentage attracted to each municipality is discussed in section 3.2.2.3 of this chapter. Similar patterns emerge when the vehicle trips and person trips are separated, where Greater Muttrah also has the highest proportions in all cases of trip purpose destination, except in the case of vehicle trips made for hospital and recreation purposes. The vital difference between vehicle trips and person trips attracted to each municipality is that the variation which is seen in *figure 3.5* in terms of proportion of each trip purpose has been reduced in the case of vehicle trips, particularly between Muttrah and the other municipalities, despite the high proportion of Muttrah population compared to the other municipalities. Thus, it can be said that vehicle trips are much lower in Muttrah than in the other municipalities, while percentages of vehicle passengers and walking trips are much higher in Muttrah.

*Figure 3.6*: Geographical Distribution of Internal Vehicle Trips by Purpose




Source: Home Interview Survey, Fieldwork , Muscat 1990.

### 3.3.3: DESTINATION PURPOSE OF EXTERNAL TRAVEL

In the recording of roadside interview data, eleven trip purpose categories were used. These were: (1) home; (2) work; (3) employer's business; (4) personal business; (5) education; (6) recreation; (7) shopping; (8) hospital; (9) serve passenger; (10) pick-up or deliver goods and (11) others. The fulfilment of any one of these purposes marked the end of a trip.

A total of 812 trips was recorded in the Roadside Interview in the Muscat Area boundary. Through trips account only for 6.9 per cent, therefore the analysis of trip destination purpose is confined to the trips which end within the Muscat Area. Trips to work have the highest proportion of total external trips that end within the Muscat Area, followed by trips to home, personal business and to serve passenger. The shares of the remaining trip purposes are low, and they vary between 0.5 per cent and 7.1 per cent (*table 3.24*). Work trips make up nearly 30 per cent of all external trips. The main mode of travel to work is private vehicle which accounts for 65.3 per cent all work trips, followed by public transport 19.4 per cent (Taxi & Pick-up drivers having another job). The other modes account for 15.3 per cent of all work trips. In eight categories of the trip purpose, private vehicle emerged as the dominant mode of travel for all internal trips ending within the Muscat Area. Trips made to serve passengers and pick-up or deliver goods are dominated by Public transport (Taxi & Pick-up) and commercial vehicles respectively. *Table 3.24* illustrates the relationship between trip purpose and mode of travel.

*Table 3.24:* Trip Purpose of External Trips End Within the Muscat Area by Mode of Travel

| Trip Purpose | Private Vehicle | | Public Transport | | Other Modes | | All Modes | |
|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| Home | 94 | 19.8% | 12 | 6.2% | 12 | 13.8% | 118 | 15.6% |
| Work | 145 | 30.6% | 43 | 22.1% | 34 | 39.1% | 222 | 29.4% |
| Employer's business | 35 | 7.4% | 4 | 2.0% | 8 | 9.2% | 47 | 6.2% |
| Personal business | 79 | 16.7% | 18 | 9.2% | 4 | 4.6% | 101 | 13.4% |
| Education | 4 | 0.8% | 0 | 0.0% | 0 | 0.0% | 4 | 0.5% |
| Recreation & Social | 39 | 8.9% | 12 | 6.2% | 3 | 3.4% | 54 | 7.1% |
| Shopping | 37 | 7.8% | 5 | 2.6% | 4 | 4.6% | 46 | 6.1% |
| Hospital | 34 | 7.2% | 18 | 9.2% | 2 | 2.3% | 54 | 7.1% |
| Serve passenger | 6 | 1.3% | 80 | 41.0% | 5 | 5.7% | 91 | 12.1% |
| Pick / deliver goods | 1 | 0.2% | 3 | 1.5% | 15 | 17.3% | 19 | 2.5% |
| Total trips | 474 | 100% | 195 | 100% | 87 | 100% | 756 | 100% |

Source: Roadside Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to column total)

3.3.3.1: BASIC PURPOSE AND HOME LINKAGE

*Table 3.25* shows that over 74 per cent of all basic external trips ending within the Muscat Area are home-based. This proportion is lower than that found in the internal trips, reflecting the high proportion of trips made to serve passengers and trips carried out to do employers' business. Work trips account for 30.1 per cent of all home-based trips and this proportion varies with cordon point as seen in the table. Home-based other trips make up 51.2 per cent of all external basic trips, while non-home-based trips account for 26.0 per cent.

*Table 3.25:* Basic Purpose and Home Linkage of External Travel

| Trip Purpose | Cordon Point (1) | | Cordon Point (2) | | Total Trips | |
|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) |
| Home - Work | 93 | 23.2% | 80 | 22.5% | 173 | 22.9% |
| Home - Others | 171 | 42.6% | 215 | 60.6% | 386 | 51.2% |
| Non-Home Base | 137 | 34.2% | 60 | 16.9% | 197 | 25.9% |
| Total | 401 | 100% | 355 | 100% | 756 | 100% |

Source: Home Interview Survey, Fieldwork, Muscat 1990 (Share in % related to row total)

3.3.4: *VEHICLES MOVEMENT BY BASIC TRIP PURPOSE*

Muscat contains a host of specialised activities spread over different areas, as seen in chapter 2, section 2.3. Since these activities are spatially separated, it follows directly that people must travel from one place to another in order to carry out the activities of their daily lives. This demand is affected by the location of residential population, the location of activities such as workplaces and shopping facilities, the nature of the available transport system, and of the activity patterns of the population(4).

Therefore, understanding and appreciating both amount and motives for movements within and between the municipalities might have great impact on alleviating traffic congestion in the future. Particularly, if the planning authorities consider the basic purpose of each trip, and accordingly provide new facilities(shopping centres, sports and recreation centres, work places) in a way that allows minimum movements of traffic between the municipalities.

*Figure 3.7* shows the movement of vehicles within and between the municipalities by basic trip purpose. Greater Muttrah accounted for 43 per cent of all basic vehicle trips; about 60 per cent of all basic trips generated from Muttrah ended within it. For the remainder, 80 per cent of them are attracted to Boashar, 16 per cent to Seeb and only 4 per cent to Al-Amarat. Work trips account for 31 per cent of all basic trips generated from Muttrah, 62 per of them ended within the municipality, while 32 per cent are attracted to Boashar. More than half of all recreation trips generated from Muttrah are attracted to the other municipalities, particularly to Boashar (34%). Hospital trips make up only 3 per cent of all vehicle trips generated from Muttrah and most of them end within Boashar municipality.

About 35 per cent of all basic vehicle trips are generated from Boashar; nearly 60 per cent of them end within the same municipality, while 30 per cent end within Muttrah, seven per cent in Seeb and three per cent in Al-Amarat. More than half of all shopping trips generated from Boashar are attracted to Muttrah, reflecting the concentration of shopping centres in this municipality. It can be seen from the figure that quite high proportions of work trips, personal and employer's business trips generated from Boashar are attracted to Muttrah.

Figure 3.7 Vehicle Trip Matrix by Basic Purpose (Note the scale)

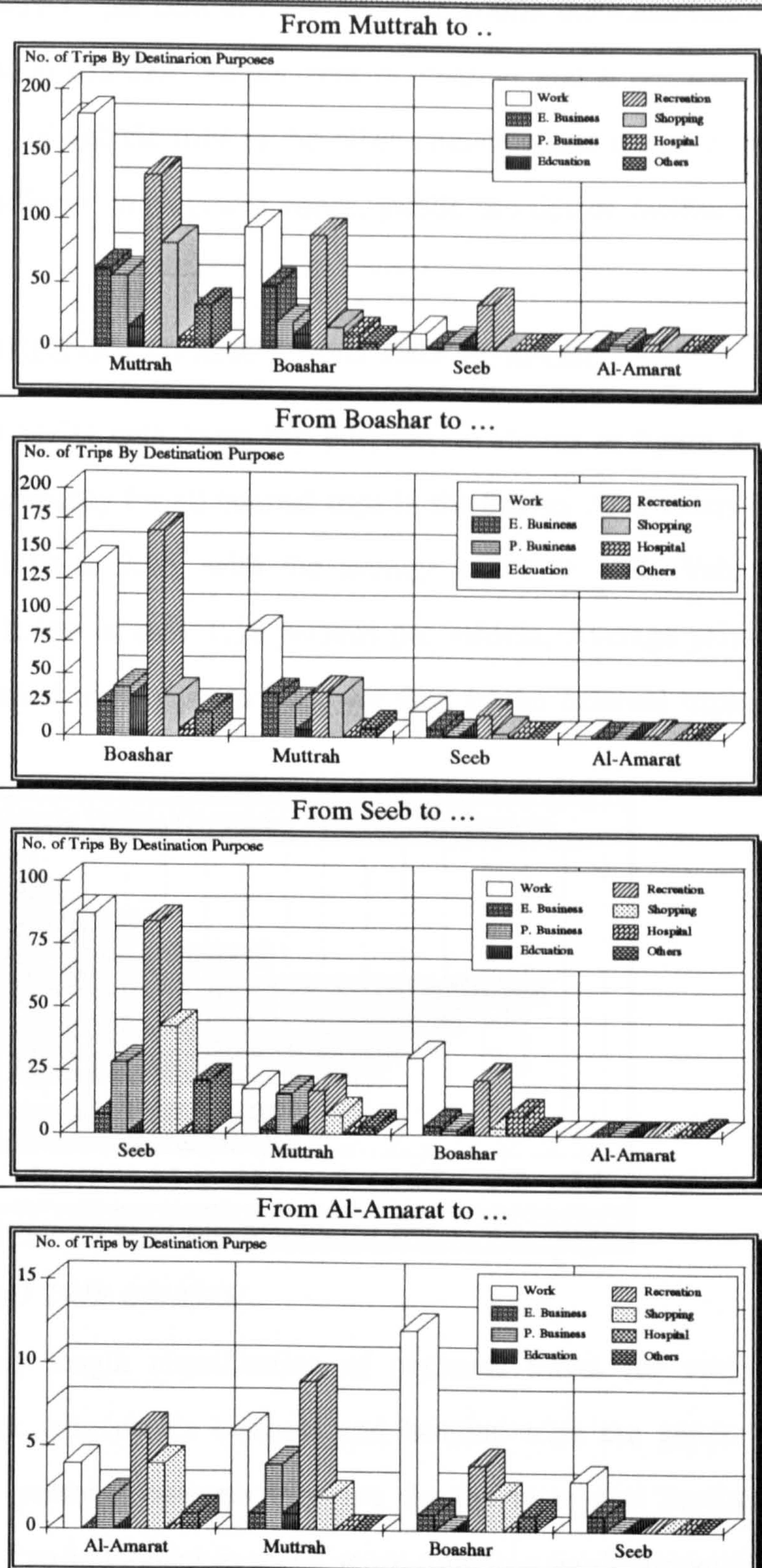
**Remark**

-- It can be seen that quite high proportions of trip movements from Muttrah towards Boashar in terms of recreation, work, hospital and trips curried out to do employer's business.

-- Quite high proportions of vehicle movements from Boashar towards Muttrah in terms of shopping, work, and trips curried out to do personal and employer's business.

-- Generally, Most of the trips end outside the Seeb municipality are in terms of work trips, recreation, hospital trips, personal business trips and low proportion of shopping trips.

-- There are no significant employment zones, public utilities or facilities in Al-Amarat. Therefore, most people commute to the other municipalities for work, personal business shopping and recreation.

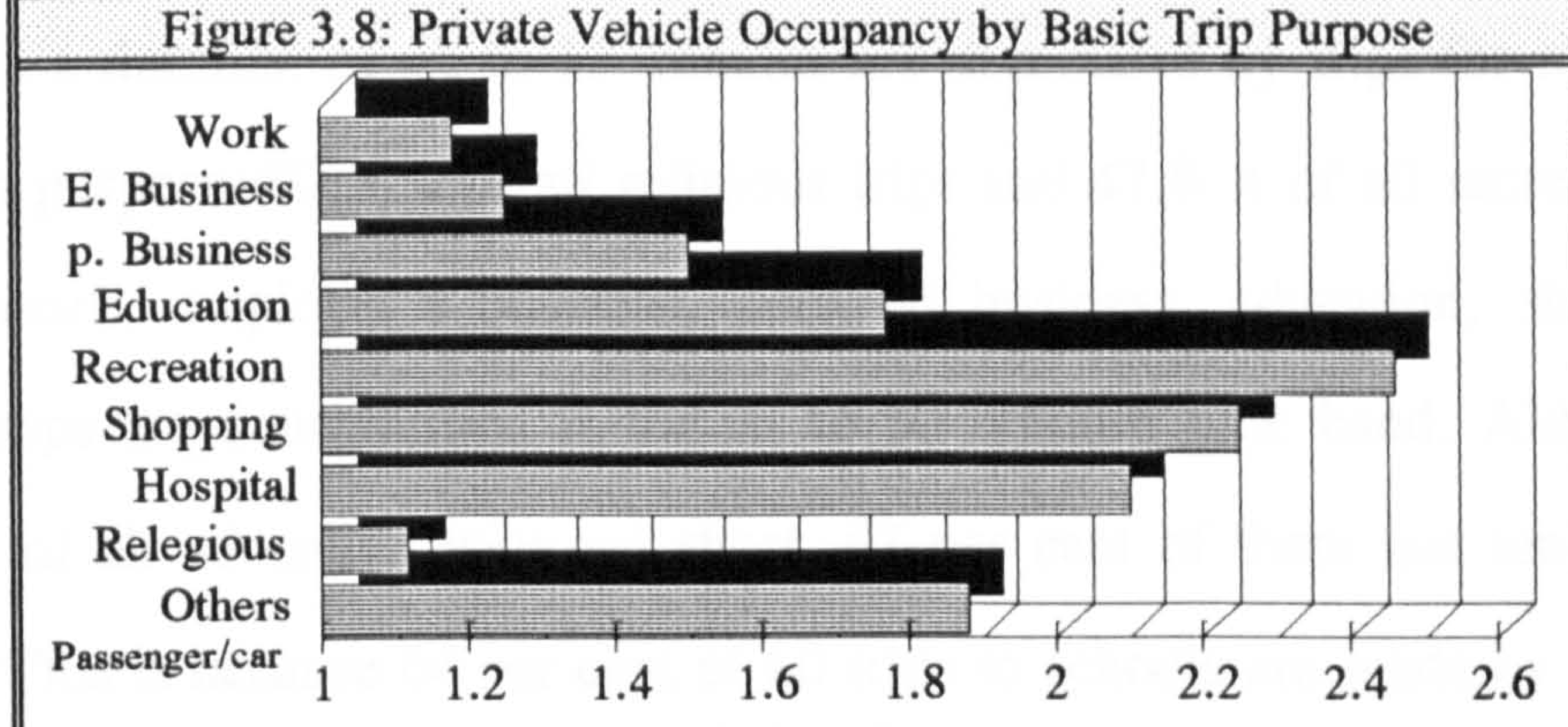



Seeb make up 19 per cent of all basic vehicle's trips; about 66 per cent of them end within it, while 17 per cent end within Boashar, 16 per cent in Muttrah and less than one per cent in Al-Amarat. Nearly 36 per cent of work trips generated from Seeb are attracted to Boashar and Muttrah. Al-Amarat accounts for nearly 3 per cent of all basic vehicle trips; only 27 per cent of these trips end within the municipality, while 35 per cent end within Muttrah, 32 per cent in Boashar and 6 per cent in Seeb. This high proportion of vehicle trips to the other municipalities is due to the fact that there are no significant employment zones, public utilities or facilities in Al-Amarat.

#### 3.3.4.1 : PRIVATE VEHICLE OCCUPANCY AND TRIP PURPOSE

Private vehicle occupancy varies with basic trip purpose, as shown in *figure 3.8.* Average private vehicle occupancy for all internal trips in the Survey Area varies by basic trip purpose from 1.12 to 2.46, with the average equal to 1.72. Vehicle occupancy for work trips is low at only 1.18 persons per vehicle. Average private vehicle occupancy for internal trips tends to be lower than in the external trips of 2.78 persons per vehicle.

Figure 3.8: Private Vehicle Occupancy by Basic Trip Purpose




Source: Home Interview Survey, Fieldwork, Muscat 1990

### 3.3.5: *TRIP PURPOSE AND TRIP LENGTH*

*Table 3.26* shows the trip length classification of personal travel for various destination purposes. Work, employer's business and hospital trips are generally long, while shopping and personal business trips are for the most part medium, reflecting the willingness of an individual to spend more time in a work commuting trip than on a trip to buy cigarettes at a local shop. Religious and education trips are short because schools and mosques are fairly distributed among the traffic zones, as discussed early in this Chapter. The proportions of the short trips vary between 12 per cent to 92.1 per cent of the hospital and religious trips respectively. Long trips range from nil for religious purposes to 59.8 per cent for hospital trips. Recreation purposes emerge with the highest proportion of external trips.

*Table 3.26*: Trip Length Classification by Destination Purpose

| Trip Length Classification | Home | work | Em's Business | Pers'l Business | Education | Recreation | Shopping | Hospi-tal | Religious | Others | All Trips |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | <------------- Destination Purpose ---------------> | | | | | | | | | | |
| Short trips | 37.3% | 22.0% | 15.2% | 27.7% | 51.4% | 35.8% | 32.8% | 12.4% | 92.1% | 37.6% | 2859 |
| Med. trips | 33.7% | 37.2% | 35.1% | 36.4% | 30.6% | 33.1% | 41.5% | 27.8% | 7.9% | 41.6% | 2706 |
| Long trips | 27.9% | 40.1% | 46.5% | 34.4% | 18.0% | 27.5% | 25.7% | 59.8% | 0.0% | 20.8% | 2304 |
| *Sub total* | *98.9%* | *99.3%* | *96.8%* | *98.5%* | *100%* | *96.4%* | *100%* | *100%* | *100%* | *100%* | *7869* |
| Exter'l trip | 1.1% | 0.7% | 3.2% | 1.5% | 0.0% | 3.6% | 0.0% | 0.0% | 0.0% | 0.0% | 92 |
| Total Person Trips | *100%* 3472 | *100%* 1138 | *100%* 282 | *100%* 346 | *100%* 628 | *100%* 900 | *100%* 696 | *100%* 97 | *100%* 253 | *100%* 149 | 7961 |

Source: Home Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to column total)

## 3.3.6: *TRIP PURPOSE AND TRIP DURATION*

### 3.3.6.1: RESIDENTS' TRIP DURATION

The duration of person trips made for various purposes is shown in *table 3.27*. Trips with a duration of up to 10 minutes are dominated by trips for religious and recreation purposes(92.5 % of all religious trips and 47.8 % of all recreation trips). Trip to work, employer's business, personal business, education, shopping and hospital trips are concentrated in the 21 to 30 minutes time band. Although more than half of all education trips are short, 67 per cent of them last longer than 10 minutes. This is because 64 per cent of all trips to schools are made by government buses or on foot.

*Table 3.27* : Duration of Internal Travel by Destination Purposes

| Trip Duration (minutes) | Home | work | Emp's Business | Pers'l Business | Education | Recreation | Shopping | Hospi-tal | Religious | Others | All Trips |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | <------------- Destination Purpose ---------------> | | | | | | | | | | |
| 0 ---- 5 | 15.7% | 12.0% | 11.3% | 11.8% | 11.1% | 14.9% | 13.1% | 4.1% | 67.2% | 11.4% | 15.6% |
| 6 --- 10 | 28.1% | 18.7% | 20.6% | 26.9% | 21.9% | 32.9% | 21.1% | 20.6% | 25.3% | 39.6% | 25.9% |
| 11 -- 20 | 29.1% | 32.9% | 43.6% | 36.4% | 37.8% | 29.1% | 43.5% | 32.0% | 6.7% | 30.2% | 31.7% |
| 21 -- 30 | 16.4% | 22.2% | 17.0% | 13.6% | 19.8% | 12.4% | 12.8% | 28.9% | 0.8% | 11.4% | 16.2% |
| 31 -- 40 | 4.1% | 5.8% | 4.3% | 5.5% | 3.5% | 3.6% | 4.2% | 4.1% | 0.0% | 2.7% | 4.2% |
| 41 -- 60 | 5.5% | 7.5% | 1.8% | 5.2% | 5.1% | 5.8% | 4.9% | 9.3% | 0.0% | 4.7% | 5.4% |
| Over 60 | 1.1% | 0.9% | 1.4% | 0.6% | 0.8% | 1.3% | 0.4% | 1.0% | 0.0% | 0.0% | 1.0% |
| Total Person Trips | *100%* 3472 | *100%* 1138 | *100%* 282 | *100%* 346 | *100%* 628 | *100%* 900 | *100%* 696 | *100%* 97 | *100%* 253 | *100%* 149 | *100%* 7961 |

Source: Home Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to column total)

3.3.6.2: INBOUND TRAFFIC TRIP DURATION

*Table 3.28* shows the trip duration of external traffic ending within the Muscat Area for various purposes. Trips, such as trips to work, employer's business, shopping and hospital trips are concentrated in the one to two hours time band, while recreation and personal business trips are in the two to three hours time band. Trips to serve passengers, pick-up or deliver goods and returning home trips are concentrated in the over three hours time band.

*Table 3.28*:Duration of External Travel by Destination Purpose

| Trip Duration (minutes) | <-------------- Destination Purpose ----------------> | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Home | work | Emp's Business | Pers'l Business | Educ-ation | Recr-eation | Shopping | Hospi-tal | Serve passenger | Pick deliver | All Trips |
| Under 15 Mi | 0.0% | 0.9% | 0.0% | 2.0% | 0.0% | 3.7% | 0.0% | 1.9% | 2.2% | 0.0% | 1.2% |
| 15 to 30 Min | 11.9% | 3.2% | 8.5% | 5.0% | 25.0% | 5.6% | 10.9% | 1.9% | 3.3% | 0.0% | 5.7% |
| 30 M to 1 hr | 21.1% | 20.7% | 25.5% | 20.8% | 50.0% | 22.2% | 19.6% | 12.9% | 11.0% | 10.5% | 19.2% |
| 1 to 2 hr | 17.0% | 43.7% | 42.6% | 23.8% | 25.0% | 24.1% | 34.8% | 48.1% | 28.6% | 15.8% | 32.5% |
| 2 to 3 hr | 17.8% | 21.6% | 14.9% | 28.7% | 0.0% | 29.6% | 19.6% | 16.7% | 22.0% | 26.3% | 21.8% |
| over 3 hr | 32.2% | 9.9% | 8.5% | 19.7% | 0.0% | 14.8% | 15.1% | 18.5% | 32.9% | 47.4% | 19.6% |
| Total | *100%* | *100%* | *100%* | *100%* | *100%* | *100%* | *100%* | *100%* | *100%* | *100%* | *100%* |
| Person Trips | 118 | 222 | 47 | 101 | 4 | 54 | 46 | 54 | 91 | 19 | 756 |

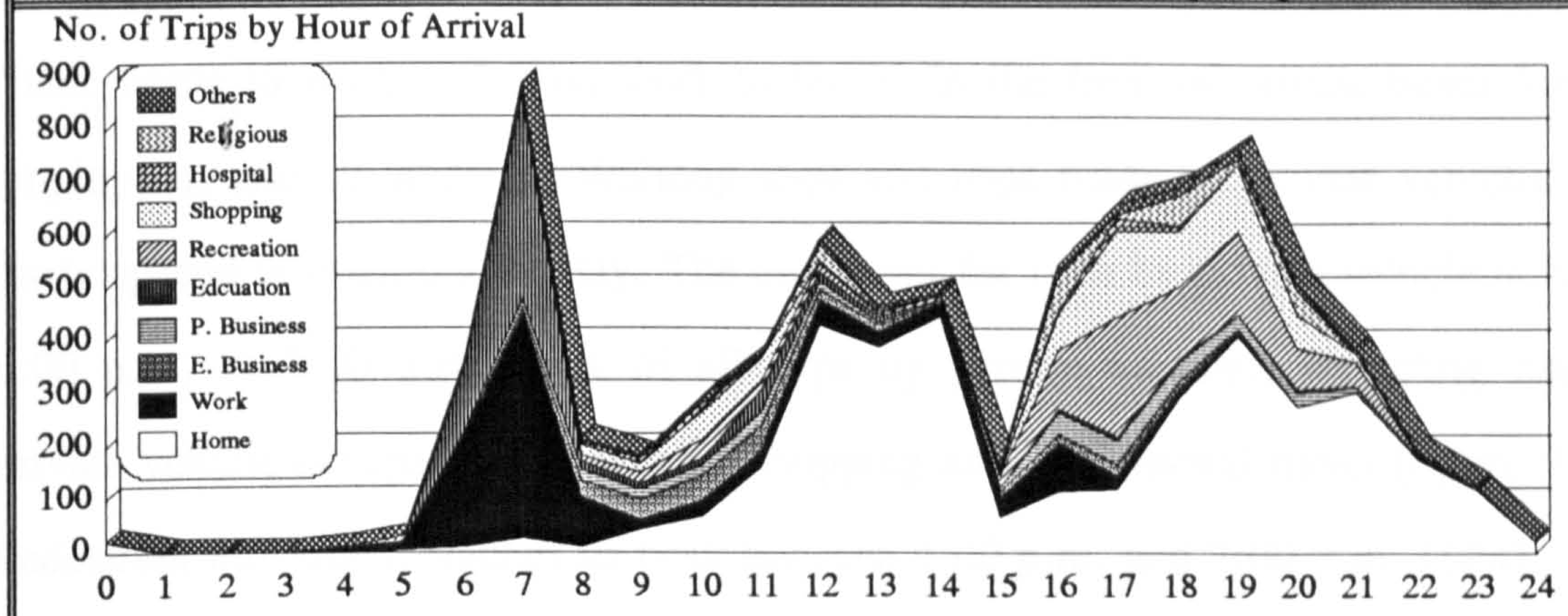
Source: Roadside Interview Survey, Fieldwork, Muscat 1990 ( Share in % related to column total)

## 3.4 - WHEN PEOPLE TRAVEL

### 3.4.1: *INTERNAL TRIP PURPOSE BY PERIOD OF ARRIVAL*

The daily cycle of travel in the Muscat Area derives mainly from the way of the life of its people. In *figure 3.9*, the internal person trips (7869) made by the residents of the households surveyed are classified by the times of their arrival at their destinations. It can be seen that there are three distinct peaks in the daily pattern of personal travel: 7:00 to 8:00 a.m. (12 % of all daily travel), noon 12:00 to 3:00 p.m. (at average 7.5 % per hour of all daily travel) and 4:00 to 10:00 p.m. (9.6 %). Generally, the peaking of personal travel in the morning rush hour is nearly three times, in the noon nearly twice, and in the evening just over twice, the average hourly travel. For the time being, the morning rush hour causes the most severe traffic problems over the Muscat Area road network, while the evening rush hours cause severe traffic congestion in the roads leading to Ruwi and Muttrah, in which commercial and retailing businesses are concentrated.

*Figure 3.9*: Hourly Distribution of Internal Person Trips by Purpose



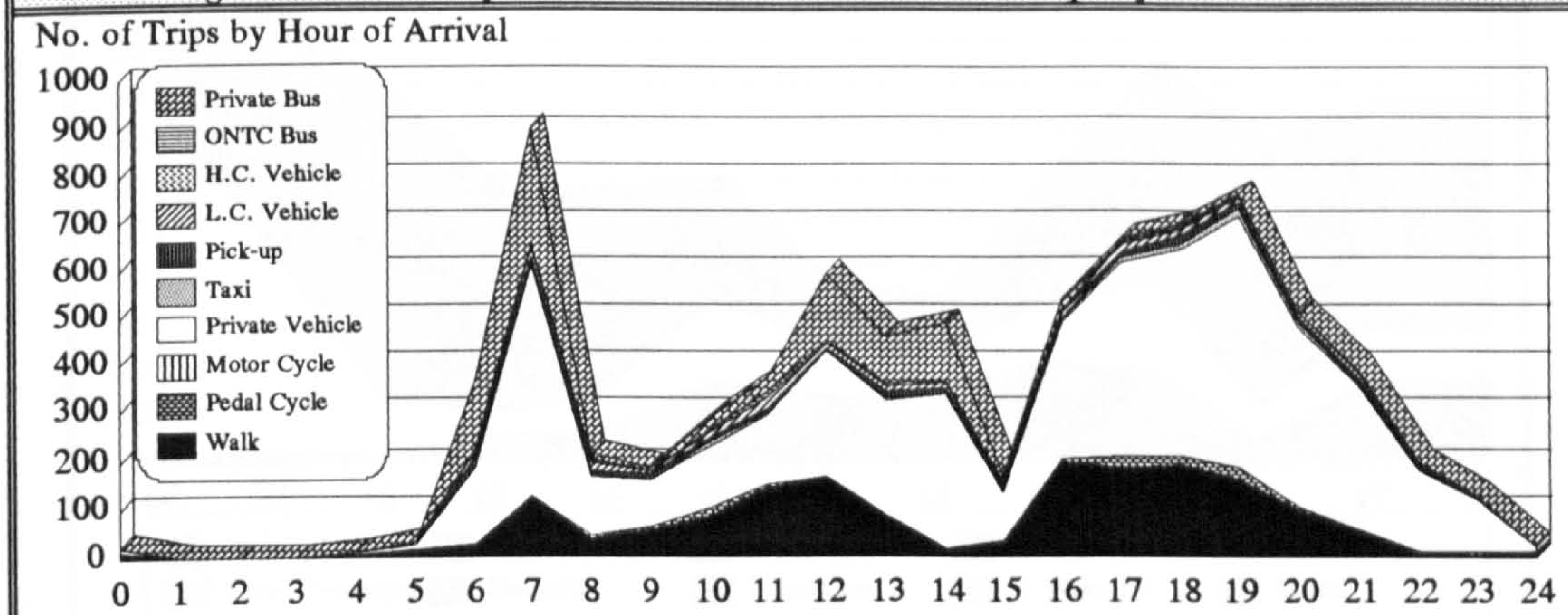

Source: The Home Interview Survey, Fieldwork, Muscat 1990

Why personal travel is organised in this way is explained by the purpose for which travel is undertaken, as seen in *figure 3.9.* It can be seen that the urban area is nearly at rest from 1:00 to 5:00 in the morning. From 6:00 a.m. to 9:00 a.m. there is a big surge of travel to work and schools. This is matched by a slightly greater movement back home between 12:00 noon and 3:00 p.m. Minor peaks of personal travel to work occur in the afternoon. Other trip purposes have their own patterns. Trips to activities associated with religious, hospital, personal and employer's business trips are fairly evenly spaced throughout the day. The principal periods for trips to shopping and recreational activities are between 4:00 p.m. and 10:00 p.m. While trips to work and school make up the greatest part of the morning peak, other trip purposes combine to form 9 per cent of morning peak hour. The noon peak, returning home trips are about 82 per cent. Travel to shopping, recreation and home account for 82 per cent of the evening peak, while the remaining trip purposes combine to form 18 per cent of the evening peak.

### 3.4.2: INTERNAL TRAVEL MODE BY PERIOD OF ARRIVAL

The proportion of the total demand served by each of the various modes of travel varies considerably with the time of the day, (*figure 3.10*). It can be seen that the characteristics of peak hour travel and variation in mode of travel throughout the day are associated with trip purpose. A much higher proportion of the total daily usage of private bus occurs during the morning and noon peak periods than in the evening peak. This is due to the fact that the government provides free transport (from home to work and from work to home) in the form of private buses for its employees, and all students. Walking trips and trips made by private vehicles are fairly spaced through-out the day. The peak hour for trips by private vehicle is from 6:00 p.m. to 7:00 p.m. (11% of all trips by private vehicle), reflecting higher private vehicle occupancy for evening shopping and recreational travel (*figure 3.9*). Pedestrian movement reaches its peak between 4:00 p.m. and 7:00 p.m. (12%). The peak hour for trips by public transport (taxi, pick-up & ONTC bus) is from 6:00 p.m. to 7:00 p.m. (10% of all trips by public transport).

*Figure 3.10*: Hourly Distribution of Internal Person Trips by Mode of Travel



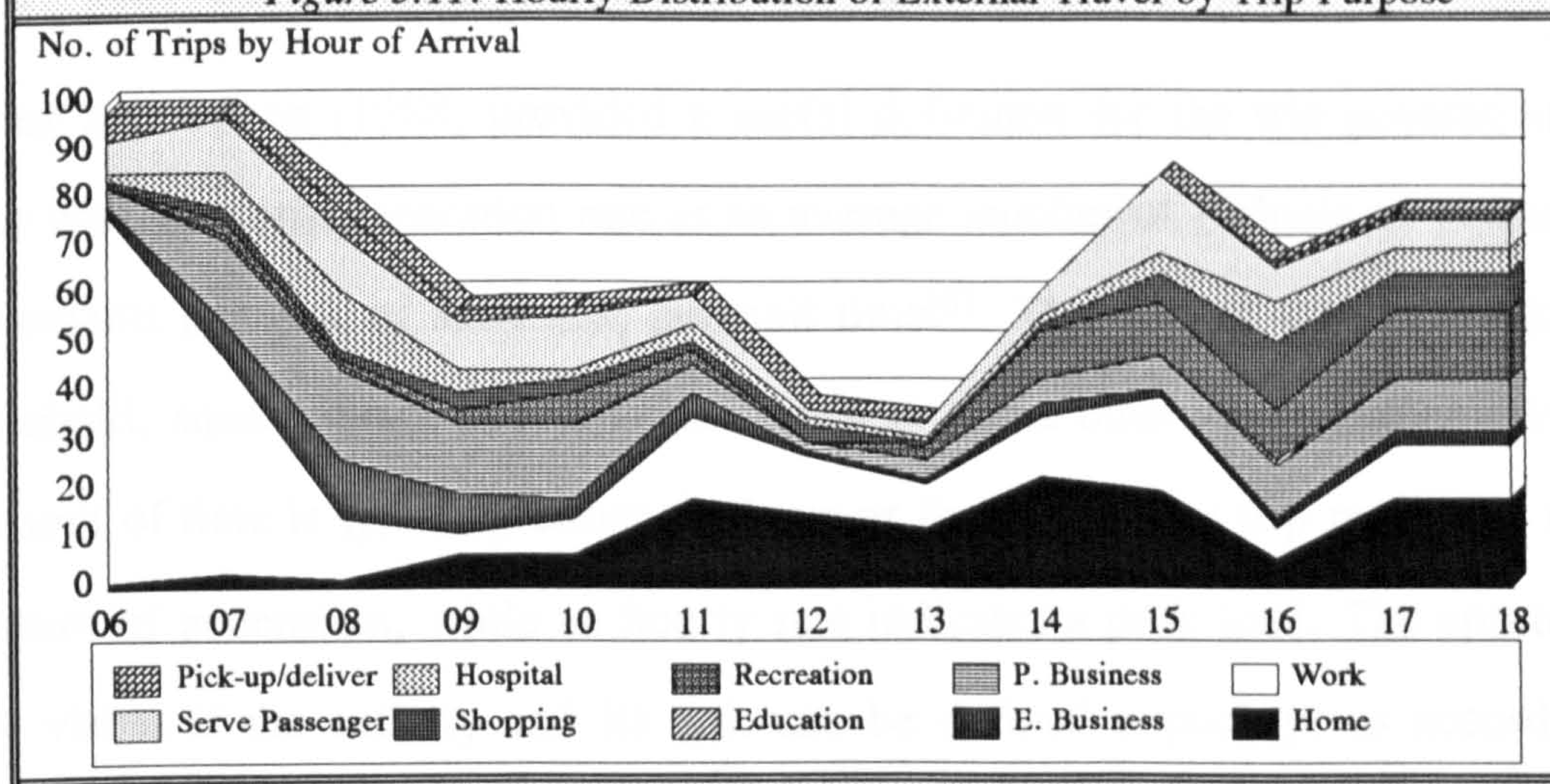

Source: The Home Interview Survey, Fieldwork, Muscat 1990

## 3.4.3: TRIP PURPOSE BY TIME OF ARRIVAL IN CORDON POINTS

*Figure 3.11* illustrates the hourly variation of all vehicle drivers interviewed in 12 hours by trip destination purpose. The figure itself does not represent the actual traffic flow entering the Muscat Area boundary during that period, (see chapter 4), but roughly it represents the same proportion of hourly variation of the actual traffic flow. It can be seen that there are two peaks, during the period of the 12 hours of daylight. The morning peak hours occur between 6:00 and 7:00 a.m. (12.5% of all travel) and the evening peak hours between 3:00 and 4:00 p.m. (11%). There is a minor peak from 5:00 p.m. to 6:00 p.m., and this accounts for 9 per cent of all travel. Generally, inbound traffic flow towards the Muscat Area builds up after 5:00 a.m. and starts declining after 8:00 p.m. with a notable drop in the traffic flow between 1:00 p.m. and 2:00 p.m.[(5)].

When the characteristics of external travel seen in terms of trip purpose, slightly similar patterns of internal personal travel appear, the only difference is that the morning peak hours are not dominated by work and education trips as seen in the internal personal travel. This is due to the fact that there is no significant number of education trips towards the Muscat Area. Therefore, the morning peak hours are dominated by trip to work (70 % of all morning peak travel). In the evening peak hours trips to other purposes mostly share the peak travel, as seen in *figure 3.11*.

*Figure 3.11*: Hourly Distribution of External Travel by Trip Purpose

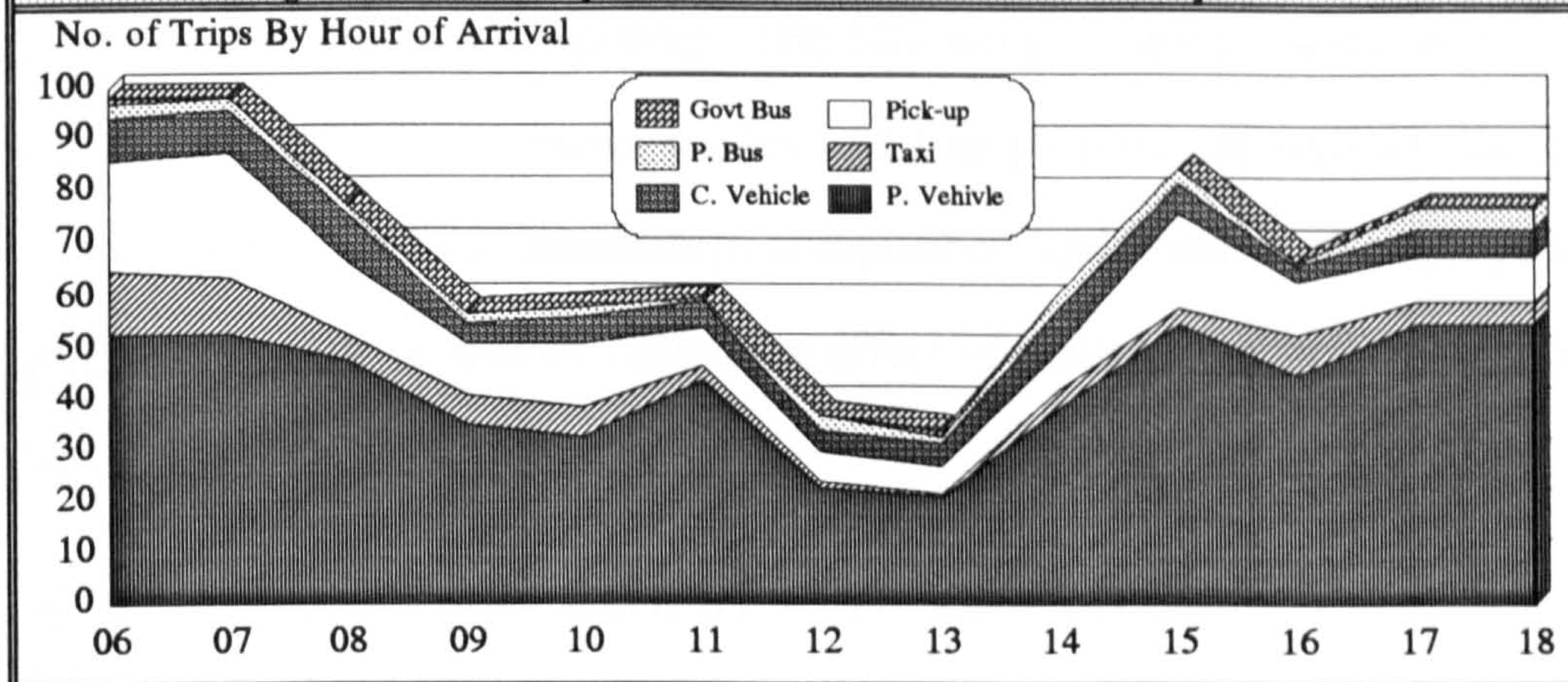



Source: The Roadside Interview Survey, Fieldwork, Muscat 1990

3.4.4: TRAVEL MODE BY TIME OF ARRIVAL IN CORDON POINTS

The proportion of daylight (12-hour) travel occurring in each hour is illustrated by mode of travel in *figure 3.12.* Private vehicles are the predominant mode of travel throughout the day, and account for over 60 per cent of all travel in both the morning and evening peak hours. Pick-up trips are more concentrated in the peak hours. The peaking of pick-up travel in the morning and evening peak hours is nearly twice the average hourly travel. The peak hours for taxi trips occur during morning peak hours, and account for 36 per cent of all taxi trips throughout the day. Other modes of travel are fairly spaced throughout the day,*(figure 3.12).*

*Figure 3.12*: Hourly Distribution of External Travel by Mode of Travel




Source: The Roadside Interview Survey, Fieldwork, Muscat 1990

## 3.5 : **TRIP GENERATION RATES**

### 3.5.1 - *TRIP GENERATION RATE DEFINITION*

Taylor and Young (1988) provided a useful definition for the trip generation rate. They described trip generation rate as an average number of (vehicle or person) trip movements per unit of activities, per unit time(6). The unit of activity could be a household, square metre of retail floor space or some other easily discernible unit. The unit of time is typically either the hour or the day. Daily trip rates give a total measure of generation, while an hourly rate indicates a peak load. The approach is only viable if the activity and its unit can be defined explicitly, as according to Brindle and Barnard (1985):-

> Movement occurs in most cases as a result of some sort of human activity occurring a particular location (buying, drinking, meeting, sleeping, etc.). The problem is then to measure the amount of such activity at a particular site. Activity, however, is an elusive concept and even when obvious measures exist (for instance the number of workers occupying an office building) these tend neither to be predictable nor stable(7).

A consequence is that trip generation rates tend to be expressed in units of physical land use, rather than activity. Brindle (1984) identified the household as one of the typical measures of land use units(8). In addition, the number of households represents an important socio-demographic unit, which can be estimated for a given area with a fair degree of reliability. Therefore, this unit is used for estimating the travel generation rates in the Muscat Area. The household travel generation rate is largely a function of many variables. The following sections discuss trip generation rates in terms of the main travel modes and trip purpose, as well as, the effect of household income, vehicle ownership, composition and number of employees on the trip generation rates. It also discusses the effect of vehicle availability per household on travel mode choice.

### 3.5.2 - *TRIP GENERATION RATE BY MODE OF TRAVEL*

The 528 households surveyed in the Muscat Area generated about 7,961 trips on a typical week day. These units housed 3,241 persons (2662 persons over five years of age), at an average rate of 6.14 persons per household. The population living in these households reported using 650 vehicles. This is an average of 1.23 vehicle per household. In the course of an average weekday, each person makes 2.99 trips and each vehicle makes 4.64 trips. There are 15.08 person trips or 5.71 vehicle trips per household each day. As previously discussed, internal trips account for the most of the generation by the households surveyed. Rates of generation are 14.9 internal and 0.18 external trips per household per day.

*Table 3.29* shows the average number of trips per household by nationality, the number of trips per person in terms of nationality and sex and the total trips made by main travel modes. There are significant variations on the trip generation rates between Omani and non-Omani households. The Omani households tend to generate more trips per day (16.94 trip) than non-Omani households (11.35), while the average number of trips for Omani persons is lower ( 4.24 trip per male Omani and 1.46 trips per female) than non-Omani persons (4.66 per male and 2.38 trip per female). This variation in the average trip generation rates between Omani and non-Omani households is mainly due to household size, where the average Omani household is twice the average of the non-Omani household.

It is apparent from the table that vehicle driver trips have the highest proportion of the all trips generated by males per day, while in the case of females the highest share of generated trips is for vehicle passenger. Although the total Omani females account for 51 per cent of all reporting Omani population, they generate only 26 per cent of all Omani trips. Thus, Omani female has the lowest average generation rate per person (1.46), and also in all cases of the travel modes.

*Table 3.29*: Trip Generation Rates by Travel Mode

| Mode | Total Person Trips | Trips per household | | | Trips per person* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Omani | | Non-Omani | | Total |
| | | Omani | Non-Omani | Total household | Male | Female | Male | Female | per person |
| Vehicle driver | 3014 | 5.68 | 5.77 | 5.71 | 1.68 | 0.24 | 2.87 | 0.53 | 1.14 |
| Vehicle passenger | 2744 | 5.96 | 3.66 | 5.20 | 1.09 | 0.89 | 0.98 | 1.47 | 1.03 |
| Public transport | 381 | 0.83 | 0.50 | 0.72 | 0.26 | 0.03 | 0.23 | 0.08 | 0.14 |
| All motorised | 6139 | 12.47 | 9.93 | 11.63 | 3.03 | 1.16 | 4.08 | 2.08 | 2.31 |
| Unmotorised | 1822 | 4.47 | 1.42 | 3.45 | 1.21 | 0.30 | 0.58 | 0.30 | 0.68 |
| Total trips per ... | 7961 | 16.94 | 11.35 | 15.08 | 4.24 | 1.46 | 4.66 | 2.38 | 2.99 |

Source: Home Interview Survey, Fieldwork, Muscat 1990 * Trips per person over five years of age

### 3.5.3 - *TRIP GENERATION RATE BY TRAVEL PURPOSES*

*Table 3.30* shows the average number of trips per household and the number of trips per person for various trip purposes, in terms of nationality, motorised and unmotorised trips. The average generation rate of travel from home to work amounts to 1.81 per household, which is mostly made by motorised means of transport. This generation rate tends to be lower than average in the non-Omani household (1.79 trip per household) and higher than average in the Omani household. Generation rates for all non-work trips by motorised forms of transport are higher for Omani than non-Omani. Omani people make twice as many trips for recreation, education and personal business, and four to six times as for hospital and religious purposes. Thus, significant increases in the overall rates of generation of non-work travel by motorised forms of transport are expected as the number of Omani households increases and the household size decreases in the Muscat Area, (the government policy is to reduce expatriate population and grant more residential plots to Omani population).

In the case of the trips generated per person, a non-Omani person generates more trips per day to work than an Omani person. The difference reflects the type of employment. The majority of non-Omani employees are working in the private sector in which each employee has to generate one trip from home to work in morning and another one in the evening. Most of the Omani employees work for the government and each one has to generate only one trip per day to work in the morning. *Table 3.30* shows that generation rates for all basic trip purposes by motorised forms of transport are slightly higher for non-Omani people than for Omani, except for personal business, religious and hospital purposes.

*Table 3.30*: Trip Generation Rates by Trip Purpose

| Trip Purpose | Total Person Trips | Trips per household | | | | | Trips per person | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Motorised | | Unmotorised | | | Motorised | | Unmotorised | | |
| | | Omani | None | Omani | None | **total** | Omani | None | Omani | None | **total** |
| ***From home to:-*** | | | | | | | | | | | |
| Work | 958 | 1.72 | 1.57 | 0.11 | 0.22 | 1.81 | 0.29 | 0.51 | 0.02 | 0.22 | 0.36 |
| Employer's business | 40 | 0.06 | 0.08 | 0.01 | --- | 0.07 | 0.01 | 0.03 | 0.01 | --- | 0.01 |
| Personal Business | 220 | 0.41 | 0.18 | 0.13 | 0.03 | 0.42 | 0.07 | 0.06 | 0.02 | 0.01 | 0.08 |
| Education | 601 | 0.98 | 0.58 | 0.42 | 0.02 | 1.14 | 0.16 | 0.19 | 0.07 | 0.01 | 0.23 |
| Recreation & Social | 744 | 1.07 | 0.77 | 0.63 | 0.05 | 1.41 | 0.18 | 0.25 | 0.11 | 0.02 | 0.28 |
| Shopping | 504 | 0.69 | 0.76 | 0.25 | 0.22 | 0.95 | 0.11 | 0.25 | 0.04 | 0.07 | 0.19 |
| Hospital | 89 | 0.21 | 0.05 | 0.01 | 0.01 | 0.17 | 0.03 | 0.01 | 0.01 | --- | 0.03 |
| Religious | 200 | 0.06 | 0.01 | 0.49 | 0.02 | 0.38 | 0.01 | --- | 0.07 | 0.01 | 0.08 |
| Others | 121 | 0.19 | 0.12 | 0.07 | 0.06 | 0.23 | 0.03 | 0.04 | 0.01 | 0.02 | 0.05 |
| ***Sub-Total*** | 3477 | 5.39 | 4.12 | 2.12 | 0.63 | 6.58 | 0.89 | 1.34 | 0.36 | 0.21 | 1.31 |
| To home | 3467 | 5.38 | 4.12 | 2.11 | 0.62 | 6.57 | 0.89 | 1.34 | 0.35 | 0.20 | 1.30 |
| Non-home based | 1017 | 1.72 | 1.70 | 0.24 | 0.17 | 1.93 | 0.29 | 0.55 | 0.04 | 0.05 | 0.38 |
| ***Total*** | 7961 | 12.48 | 9.94 | 4.47 | 1.42 | 15.08 | 2.07 | 3.23 | 0.75 | 0.46 | 2.99 |

Source: Home Interview Survey, Fieldwork, Muscat 1990.

### 3.5.4 - *THE EFFECT OF HOUSEHOLD INCOME ON TRIP GENERATION*

Household income seems to be an important determinant of the amount of travel generation as seen in *table 3.31*. The total amount of travel and the characteristics of travel by car-owning and non-car-owning households differ with household income. At all income levels, car owners generate more travel than non-car owners. Car-owning households generate an average 16.1 trips per day whereas non-car owners generate 10.6 trips. Although car-owning households generate an average 13.1 trip per day by motorised forms of transport, there is a great variation from 6.5 trips in households with an income of less than R.O. 150 to 20.2 trips in those with over R.O. 1,000. The latter group generates travel at a rate over three times that of the former.

As shown in *table 3.31*, there is a consistent increase in travel generation by both car owners and non-car owners with the increase in income. Non-car owners in the income group from R.O. 601 to 800 show a reversal of this trend and then an increase, probably because the Home Interview sample is too small to sufficiently represent non-car owners households with an income of over R.O. 600, (only 3 households surveyed).

*Table 3.31*: Effect of Household Income on Travel Generation

| Income Class In Rail Omani | Non- car-owing households | | | | | Car-owing households | | | | | All Trips/ House |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unmotorised | | Motorised | | All | Unmotorised | | Motorised | | All | |
| | No. of trips | Trips / House | No. of trips | Trips / House | Trips/ House | No. of trips | Trips/ House | No. of trips | Trips / House | Trips/ House | |
| > 150 R.O. | 95 | 5.9 | 43 | 2.7 | 8.6 | 7 | 3.5 | 13 | 6.5 | 10.0 | 8.8 |
| 151 to 200 | 139 | 5.3 | 121 | 4.7 | 10.0 | 46 | 3.8 | 78 | 6.5 | 10.3 | 10.1 |
| 201 to 400 | 193 | 5.5 | 221 | 6.3 | 11.8 | 361 | 3.3 | 1010 | 9.4 | 12.8 | 12.5 |
| 401 to 600 | 84 | 4.7 | 116 | 6.4 | 11.1 | 359 | 3.2 | 1380 | 12.2 | 15.4 | 14.7 |
| 601 to 800 | 10 | 5.0 | 2 | 1.0 | 6.0 | 205 | 3.0 | 975 | 14.1 | 17.1 | 16.8 |
| 801 to 1000 | 4 | 4.0 | 6 | 6.0 | 10.0 | 177 | 3.0 | 821 | 14.2 | 17.2 | 17.1 |
| < 1000 R. O | 0 | 0 | 0 | 0 | 0 | 142 | 2.1 | 1353 | 20.2 | 22.0 | 22.3 |
| Total | 525 | 5.4 | 509 | 5.2 | 10.6 | 1297 | 3.0 | 5630 | 13.1 | 16.1 | 15.1 |

Source: Home Interview Survey, Fieldwork, Muscat 1990.

### 3.5.5 - *EFFECT OF HOUSEHOLD SIZE ON TRIP GENERATION*

The household size plays an important role in determining rates of travel generation. It is apparent from *table 3.32* that the rate of generation increases gradually with increase in number of persons per household. As previously discussed in Chapter 2, the average household size in the Muscat Area is 6.14 persons. This average household size tends to be higher in the Omani households (7.38 persons) and lower in the non-Omani households (3.65 persons). Thus, this variation has a great impact on the amount of travel generation per household.

Although Omani households generate an average of 16.9 trips per day, there is a wide variation from 7.7 trips in households with 1 to 3 persons to 30.1 trips in those with over 11 persons. Non-Omani households, on the other hand, generate an average of 11.4 trips, and the variation ranges between 8.2 to 16.0 trips per day. This significant variation between Omani and non-Omani households shows the underlying influence of household size in determining the rates of travel generation.

*Table 3.32*: Effect of Household Characteristics on Travel Generation

| Item | Omani Households | | | non-Omani Households | | | All the households | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of trips | No. of house | Trips / house | No. of trips | No. of house | Trips / house | No. of trips | No. of house | Trips / house |
| ***Persons per household*** | | | | | | | | | |
| 1 - 3 persons | 347 | 45 | 7.7 | 673 | 82 | 8.2 | 1020 | 127 | 8.0 |
| 4 - 7 persons | 2158 | 161 | 13.4 | 1309 | 93 | 14.1 | 3467 | 254 | 13.6 |
| 8 - 11 persons | 2163 | 103 | 21.0 | 16 | 1 | 16.0 | 2179 | 104 | 21.0 |
| Over 11 persons | 1295 | 43 | 30.1 | 0 | 0 | 0 | 1295 | 43 | 30.1 |
| ***Employees / household*** | | | | | | | | | |
| 1- 2 employees | 849 | 94 | 9.0 | 941 | 107 | 8.8 | 1790 | 201 | 8.9 |
| 3 -4 employees | 1291 | 93 | 13.9 | 777 | 53 | 14.7 | 2068 | 146 | 14.2 |
| 5 -6 employees | 1826 | 96 | 19.0 | 252 | 15 | 16.8 | 2078 | 111 | 18.7 |
| Over 6 employees | 1997 | 69 | 28.9 | 28 | 1 | 28.0 | 2025 | 70 | 28.9 |
| ***Vehicles per household*** | | | | | | | | | |
| No vehicle | 840 | 64 | 13.1 | 307 | 34 | 9.0 | 1147 | 98 | 11.7 |
| One vehicle | 2645 | 181 | 14.6 | 1356 | 119 | 11.4 | 4001 | 300 | 13.3 |
| Two vehicles | 1435 | 67 | 21.4 | 320 | 22 | 14.5 | 1755 | 89 | 19.7 |
| Three or more | 1043 | 40 | 26.1 | 15 | 1 | 15.0 | 1058 | 41 | 25.8 |
| ***Total trip/household*** | *5963* | *352* | *16.9* | *1998* | *176* | *11.4* | *7961* | *528* | *15.1* |

Source: Home Interview Survey, Fieldwork, Muscat 1990

### 3.5.6 - *EFFECT OF NUMBER OF EMPLOYEES ON TRIP GENERATION*

This study reveals that the average number of employees per Omani household is 4.47 persons (including students) and 2.38 for non-Omani household, while the overall number is 3.77 persons employed per household. A comparison between the average number of the persons and the employed per household for the Omani and non-Omani households indicates a higher proportion of employed people per non-Omani household than Omani. Therefore, there is no significant variation between Omani and non-Omani households in terms of travel generation rates in each employment group, ( *table 3.32*).

There is a consistent increase in travel generation by both Omani and non-Omani households with the increase in the number of employed people. The variation on travel generation for Omani and non-Omani households is mostly the same, from about 9 trips in households with 1 to 2 employed to over 28 trips in those with more than 6 employed persons.

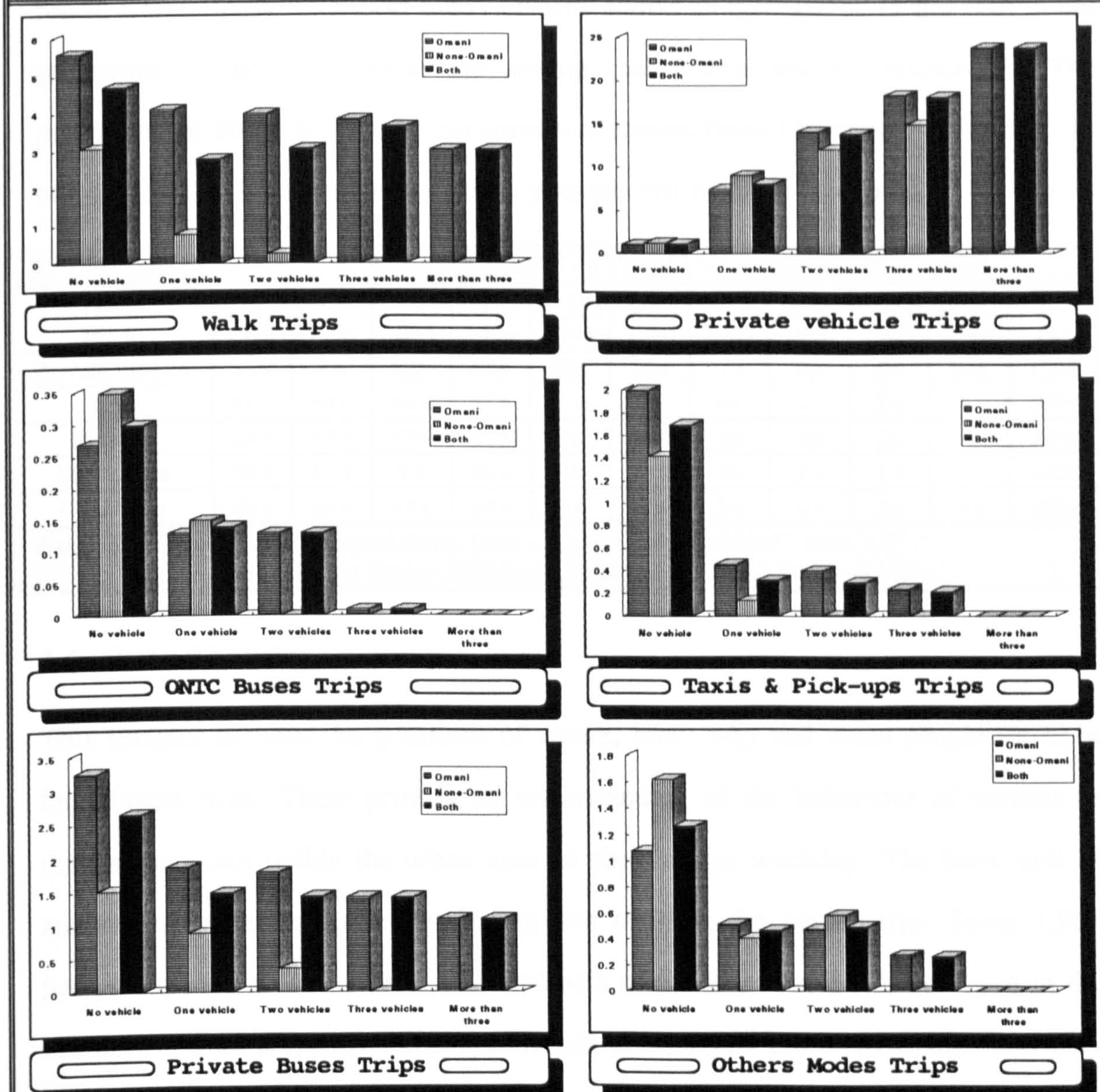
### 3.5.7 - *EFFECT OF CAR AVAILABILITY ON TRIP GENERATION*

Car availability is a highly significant factor in the generation of travel, and this is related to family size and other social characteristics of the household. As previously mentioned in the car availability analysis (Chapter 1), 81.4 per cent of the households in the Muscat Area have a car available. Of these, 69.8 per cent have one car, 20.7 per cent have two cars and 9.5 per cent have three cars or more. Car-owning households generate an average of 16.1 trips per day whereas non-car owners generate 10.6 trips. As expected, multi-car ownership produces higher generation rates than single-car ownership. The average generation rate for all car-owning households is 16.1 trips per day, the typical household with two cars generates 19.7, and the household with three (or more cars) generates 25.8 trips per day, as shown in *table 3.32.*

Although multi-car households account for 30.2 per cent of all car-owning households, they generate about 41.3 per cent of all the car-owning trips. The tendency to use private cars rather than use other modes of travel increases with higher car ownership. Only 10 per cent of all trips in non-car households are made by private vehicles, whereas the corresponding proportions for one-, two- and for three (or more)-car households are 60, 72 and 82 per cent respectively. *Figure 3.13* illustrates the effect of vehicle availability on the daily generation rates per household by mode of travel.

Household size also shows marked increases in the generation of travel. At all car ownership levels, Omani households generate more travel than non-Omani. Although Omani households generate an average 16.9 trips per day, there is a wide variation from 13.1 trips in households with no vehicle to 26.1 trips in those with three (or more) cars. The corresponding proportions for non-Omani households are 11.4, 9.0 and 15.0 trips respectively. The latter group in the Omani households generates travel at a rate nearly three times that of the former, while for non-Omani it is nearly double, confirming the influence of household size in determining rates of travel generation.

*Figure 3.13:* Household Daily Trip Rates by Mode of Travel (No. of person trips per household)




Source: Home Interview Survey, Fieldwork, Muscat 1990

### 3.5.7.1- EFFECT OF CAR AVAILABILITY ON TRAVEL MODE CHOICE

The use of private vehicle is highly significant in the households with one or more vehicles available. Over 97 per cent of all private vehicle trips are made by members of households who have a vehicle available. At the other end of the scale, about 64 per cent of taxi trips and 51 per cent of ONTC bus trips are made by members of households without a vehicle available.

*Table 3.33* shows the effect of vehicle availability on travel mode choice as recorded in the Muscat Area in 1985 and 1990. A comparison of the effect of household vehicle availability on travel mode choice with those observed in the recent Capital Area Transport Study (1985), shows an increase of 14 per cent in the proportion of private vehicle use among the vehicle owners households. The proportion of ONTC bus use by car owners increases from 15 per cent in 1985 to 41 per cent in 1990, reflecting the tendency to use this mode of transport.

*Table 3.33:* Effect of Vehicle Availability on Travel Mode Choice (1985 & 1990)

| Travel Mode | No car | | One car | | Two cars | | Three cars | | Over three | | All |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1990 | 1985 | 1990 | 1985 | 1990 | 1985 | 1990 | 1985 | 1990 | (%) |
| Private vehicle | 15% | 3% | 52% | 52% | 20% | 26% | 7% | 9% | 6% | 10% | 100% |
| Taxi | 41% | 64% | 44% | 27% | 9% | 9% | 4% | -- | 2% | - | 100% |
| Pick-up | 34% | 47% | 52% | 41% | 9% | 10% | 3% | 3% | 2% | - | 100% |
| ONTC bus | 85% | 51% | 9% | 36% | 3% | 11% | 2% | 2% | 1% | - | 100% |
| Other Bus | 49% | 24% | 38% | 48% | 8% | 17% | 3% | 6% | 2% | 5% | 100% |

Source : 1- Capital Area Transport Study (cats - Roadside Interview)1985" table 3.8"
2 -Home Interview Survey, Fieldwork 1990 ( Share in % related to column total)

## 3.6: CONCLUSION

This Chapter answers the questions of where, how, why and when people travel in the Muscat Area. These provide an understanding of the behaviour of persons as they move about within the urban area on the average weekday. The basic unit of analysis of travel habits undertaken in this study is the person trip. Some 7,961 person trips are made by the 2,662 members of the 528 households surveyed in the Muscat Area on a typical weekday. Of this total, 7,869 are internal trips and only 92 are external trips. A high proportion of traffic movement into the Study Area boundary are internal destination trips. Over 93 per cent of the interviewed vehicle drivers' trips end within the Muscat Area boundary, while through trips, which pass through without a significant stop, account for nearly 7 per cent of all traffic.

Almost half of all internal trips have at least one end within Greater Muttrah; 27 per cent are either to or from Boashar, 23 per cent to or from Seeb and only 5 per cent of all internal trips have one end within Al-Amarat. Al- Batinah Region emerges as the highest external traffic generation zone. More than 51 per cent of trips end within the Muscat Area and 40 per cent of all passing traffic are generated from this region. Seeb plays the same role as Muttrah in internal destination traffic, where 43 per cent of all internal destination traffic end within this municipality.

The pattern of personal travel is indicated by the location of trip origin and destination. Whereas traffic zones and municipalities are defined with regard to neighbourhood groupings, personal movements are represented by desire lines and indicated by trip length. About 36 per cent of all internal trips made by members of the households are short trips (occurring wholly within zones); 34 per cent medium trips (between zones); 29 per cent long trips (between municipalities), and only one per cent of all internal trips occur between the Study Area and points outside it.

Of all internal weekday person trips by the residents of the surveyed households, 58.2 per cent are made by private vehicles; 21.9 per cent on foot; 11.2 per cent by private buses; 4.7 per cent by public transport; and 4 per cent by other minor modes of transport. All external trips by the residents are made by private vehicles or pick-ups. When modes of personal internal travel are considered in terms of Omani and non-Omani, a clear picture emerges of non-Omani as the people with high proportion of their trips made by private vehicle. About 71.4 per cent of their total trips are made by this mode, compared with 53.8 per cent of Omani using the same travel mode.

About 7282 vehicles entered the Study Area during the Roadside Interview, of which, 52.2 per cent were private vehicles; 20.2 per cent were pick-ups; and 27.6 per cent were other modes of travel. This high share of pick-up movements along the Study Area boundary reflects the dominating role of the pick-ups as the main mode of public transport between the Muscat Area and the rest of the country, which is also evident from average vehicle occupancy and number of trips per day. Of 7282 vehicles, 812 vehicle drivers were interviewed in which 93 per cent of the interviewed had destinations within the Muscat Area. The trips passing through the

Study Area accounted for 7 per cent. More than half of the vehicle drivers interviewed along the Study Area boundary (54.7%) were travelling frequently.

Over 87 per cent of all basic internal trips made by the residents are home-based, thus emphasising the strong influence of home locations on the travel pattern. The proportion of home-based travel varies with purpose: 91 per cent for work travel down to 86 per cent for all other travel purposes. Home-based work trips account for 23.7 per cent of all basic internal trips. About 91.6 per cent of these involve travel by motorised means of transport which are mainly made by vehicle drivers(69%). Home-based other trips make up 63.6 per cent of all basic trips, nearly 70 per cent of these are made by motorised mode of travel in which 38 per cent as vehicle drivers. Non-home-based trips account for 12.8 per cent of all basic internal trips, a high proportion of these involve travel for employer's business and personal business, largely performed by vehicle drivers.

Almost 30 per cent of all internal basic trips generated from home on weekdays is related to work or employer's business. Shopping (15 %), school trips (17 %) and trips for various personal affairs account for the remainder. Travel mode choice varies with basic trip purpose. Of all internal work trips, 64.1 per cent are made by private vehicles, 16.6 per cent by private buses, and 7.9 per cent on foot 4.9 per cent by light commercial vehicles. The main mode for education trips is private (also government) buses accounting for 39.3 per cent, followed by private vehicle 34.2 per cent and 24.5 per cent of all education trips are made on foot. For recreation, shopping, hospital, employer's and personal business trips, private vehicle is the major mode; 68 per cent of recreation, 69 per cent of shopping, 73 per cent of employer's business and 70 per cent of personal business trips. Walking is particularly significant as a mode of travel for religious purposes.

Over 74 per cent of all basic external trips ending within the Muscat Area are home-based. This proportion is lower than that of the internal trips, reflecting the high proportion of trips made to serve passengers. Work trips account for 30.1 per cent of all home-based trips. Home-based-other trips make up 51.2 per cent of all external basic trips, while non-home-based trips account for 26.0 per cent. Trips to work have the highest proportion of all external trips ending within the Muscat Area, followed by trips to home, personal business and trips to serve passengers. The shares of the remaining purposes are low, and vary between 0.5 per cent and 7.1 per cent. The main mode of travel to work is private vehicle, accounting for 65.3 per cent of all work trips, followed by public transport 19.4 per cent, while the other modes account for 15.3 per cent of all work trips. Private vehicle is the dominant mode of travel for all internal trips ending within the Muscat Area, except in case of trips made to serve passengers and pick-up or deliver goods which are dominated by public transport and commercial vehicles respectively.

About 20 per cent of all internal trips in the Muscat Area are less than 5 or more than 30 minutes in length, 26 per cent are between 6 and 10 minutes, 32 per cent between 11 and 20 minutes and 16 per cent between 21 and 30 minutes. There is a wide variation in trip duration among modes of travel. More than half of all trips with a duration of less than 10 minutes are made on foot and mostly for religious and recreation purposes. As for trip purposes, trip to work, employer's business, personal business, education, shopping and hospital trips are concentrated in the 21 to 30 minutes time band in which 70 per cent of them are made by private vehicles.

When internal person trips (7869) made by the residents are classified in terms of the times of their arrival at their destinations, three distinct peak hours appear. The peaking of personal travel in the morning rush hour is nearly three times the average hourly travel, while at noon it is nearly twice and in the evening it is just over twice. The characteristics of peak hour travel and variation in mode of travel throughout the day are associated with trip purpose. A much higher proportion of the total daily usage of private buses occurs during the morning and noon peak periods than in the evening peak. Walking trips and trips made by private vehicles are fairly spaced throughout the day. The peak hour for the trips made by private vehicle is from 6:00 p.m. to 7:00 p.m. Pedestrian movement peaks between 4:00 p.m. and 5:00 p.m. and trips made by public transport from 6:00 to 7:00 p.m.

The average private vehicle occupancy for all internal trips in the Muscat Area is 1.72. This occupancy varies according to basic trip purpose: about 1.12 persons per vehicle for religious trips, 2.46 persons per vehicle for recreation trips and 1.18 to 2.25 for most other trips purposes. Vehicle occupancy for work trips is low, (only 1.18 persons per vehicle). The average private vehicle occupancy for internal trips tends to be lower than in the external trips (2.78 person per vehicle).

The 528 households surveyed in the Muscat Area generate about 7,961 trips on a typical week day. These units housed 3,241 persons (2662 persons over five years of age), at an average rate of 6.14 persons per household. The population living in these households use 650 vehicles. This is an average of 1.23 vehicle per household. In the course of an average weekday, each person makes 2.99 trips and each vehicle makes 4.64 trips. There are 15.08 person trips or 5.71 vehicle trips per household each day. The internal trips account for most of the generation by the households surveyed . Rates of generation are 14.9 internal and 0.18 external trips per household.

There is a wide variation in trip generation between the Omani and non-Omani populations. The Omani households tend to generate more trips per day (16.94 trip) than non-Omani household (11.35). The average number of trips for Omani person is lower than non-Omani person . This variation in the average trip generation rates between Omani and non-Omani population is mainly a function of household size, where the average Omani household size is twice that of the non-Omani. The large number of trips generated per Omani household and the drop in trip per person, indicate that there is a minimum number of trips associated with earning a living and running a household. These trips are made regardless of household size. Therefore, in the future, the average trip making rate per person among the Omani is expected to rise because a greater percentage of the Muscat population will be in small households which exhibit higher average trip rates per person than larger households.

Car availability has a great effect on travel generation. Car-owning households in the Muscat Area generate an average 16.1 trips per day compared with 10.6 for non-car owners. Whereas car-owning households with only one car generate 13.3 trips per day, those with two generate 19.7 and those with three or more generate nearly 29. Thus, future increase in car availability in Muscat will mean an increase in the overall rate of travel generation per unit population.

Household income also affects travel generation. Car-owning households receiving about 1000 Rial Omani per month average 22 trips per day compared with 10 trips per day for those receiving 150 Rial Omani or less per month. Rates of travel generation also depend on the number of employed people per household. The variation in travel generation differs from about 9 trips in households with 1 to 2 employed to over 28 trips in those with over 6 employed.

## 3.7: REFERENCES

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# CHAPTER 4

## *ROAD NETWORK DEVELOPMENT*

### 4.0 : INTRODUCTION

Chapters 2 and 3 show how the land use and the trip characteristics are inextricably linked. In this chapter, the aim is to illustrate how the existing road network currently serves the needs of the Muscat Area, and the extent to which it can cope with traffic movements.

The early part of this chapter describes road network development and identifies major Muscat road network planning issues and planning policies, including planning organisations, road planning and project implementation problems. The present and potential deficiencies of the existing road network are examined, some of which show signs of significance such as insufficient local access and roads in the major commercial to areas, traffic congestion and accidents, and the dependence upon the dual carriageway (east-west corridor) as the only principal route through the Muscat Area. The major issues and policy options for development of the Muscat Area road network are also discussed.

### 4.1: ROAD NETWORK DEVELOPMENT

The economy of Oman was traditional in character before the development of the oil sector which set in motion the present structural transformation. It was based upon agriculture - largely subsistence agriculture - fisheries, trade and handicrafts. This largely self-sufficient agricultural economy placed a limited demand on the transport system as the bulk of marketed products moved mainly short distances, generally within the range of animal transport. Few products were carried over longer distances, most of which were carried along the coast by 'dhow'. This was the picture which characterised life in Oman, and the neighbouring Gulf countries before the discovery of oil. Abu-Ayyash described the life condition in the Arabian Gulf region prior to oil discovery, saying:-

> The dearth of natural resources in the pre-oil Arabian Gulf States hampered their economic development for many years. Economic life in the region depended on the sectors characterised by meagre potential and little financial return. The relatively productive sectors were agriculture, cattle raising, trade, fishing, and pearling. Agricultural activities were restricted to small patches in oases and areas of ground water potential. Grazing and animal raising were mainly confined to desert wadis where nomads could find relatively rich pastures. Trade and commercial activities expanded to cover a vast area extending from India to East Africa. However, such activities were limited since they were associated with weak economies, and depended on primitive sea transportation, i.e. sailing boats. Fishing and pearling were considered the basic economic activities, since they were the major source of financial revenue and job opportunities for the region's population(1).

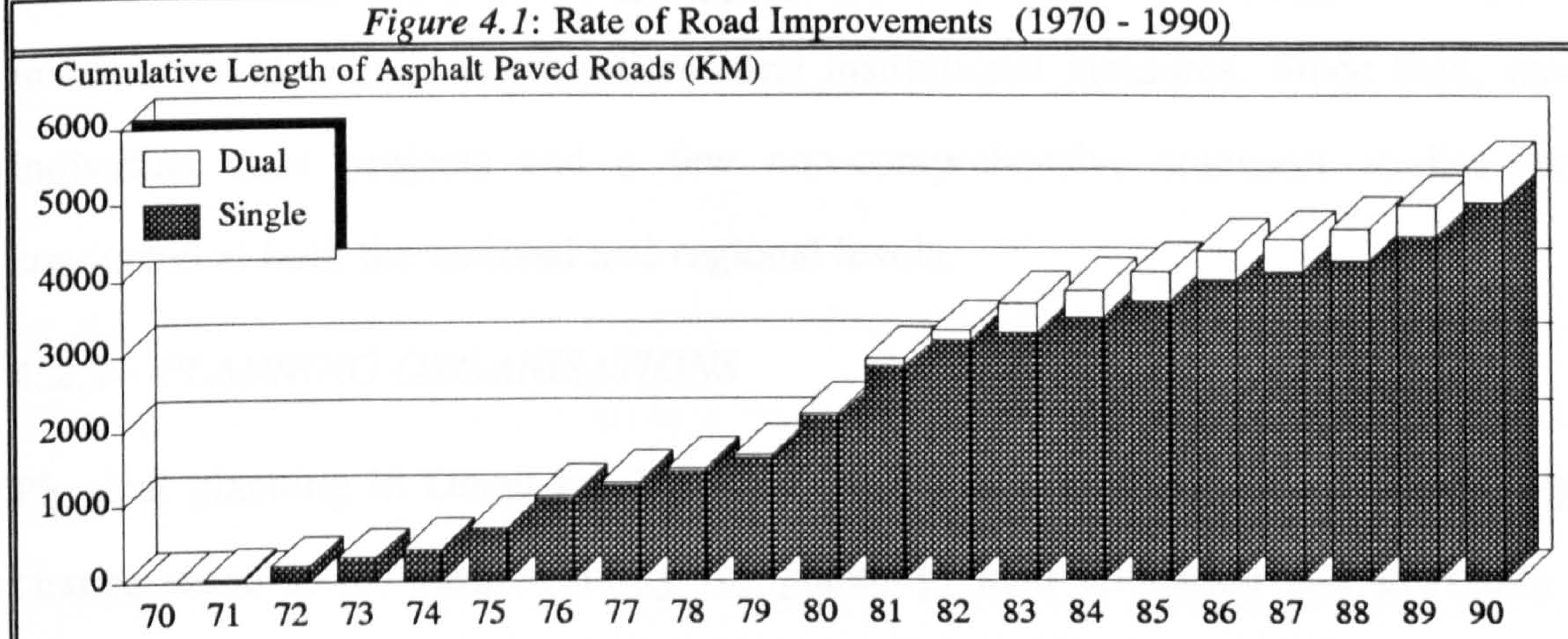
However, the situation changed radically with the discovery of oil. Oil has transformed the economies of the Gulf area, and Oman is no exception. Wealth from oil has given Omani nation a new life and hope, which revived Oman's stagnant economy and made development programmes possible. Naturally as the economy expanded the demand for improvement in the road network grew. Before 1970 there were only 10 km of asphalt road, running from the palace in Muscat town to the airstrip in Ruwi. However, civilians were banned from driving and few places were accessible by road(2). In addition, there were only 1,817 km of graded tracks, and the remaining tracks, totalling over 7,000 km throughout the country, were neglected(3).

Since 1970, the budget allocations for the transport sector and particularly road construction have formed a significant part of government development expenditures, reflecting the prior role of transport in integrating the country - politically and economically - and providing adequate facilities to international trade. In 1971 and 1972, budget allocations for the development of roads represented 23 per cent and 17 per cent of the total government expenditure respectively. These figures do not take into account the budget set aside for roads in Dhofar, which were separately allotted to the Dhofar Development Department(4). During the Second Five-Year Development Plan (1981 - 1985), a sum of RO. 281.8

million ($820 million) was spent on road development, which amounted to 10.2 per cent of the total government development expenditure. In the Third Five-Year Development Plan (1986 - 1990), the figure was about RO. 140 million[(5)], while for the Fourth Five-Year Development Plan (1991 - 1995), a sum of RO. 60.225 million (4.68% of the total) has been allocated for the Ministry of Communications for road network development throughout the country excluding the Muscat Area. Since Muscat Municipality is the agency responsible for planning, construction and maintenance of the Muscat Area road network, the road development budget for the Muscat Area is included within the RO. 42.125 million overall budget of the municipality[(6)] (3.28% of the total government expenditures).

By the end of 1990, a total of 4,995 km asphalt paved roads and 20,811 km graded roads were built throughout the country, for an average annual increase of 60 per cent and 14 per cent respectively since 1970. Of the 4,995 km asphalt roads, 418 km were dual carriageways[(7)]. The development of roads was largely concentrated in the Muscat Area, along the Al-Batinah coastline and Eastern Hajar. There was road investment also in the Salalah area of Dhofar. *Figure 4.1* illustrates the rates of increase in asphalt paving of roads, from 1970 to 1990.

*Figure 4.1*: Rate of Road Improvements (1970 - 1990)




Asphalt Roads in the Sultanate of Oman year to year growth rates

| Year | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G.Rates | 170 | 633 | 54 | 42 | 66 | 52 | 16 | 15 | 28 | 32 | 33 | 13 | 4 | 6 | 6 | 8 | 3 | 3 | 7 | 10 |

Sources: 1-The Statistical Year Book -July 1991. 2- Oman Facts & Figures-1990."own calculation"

## 4.2: MUSCAT ROAD PLANNING AND POLICY

### 4.2.1-*GENERAL*

Transport planning activities in Oman emerged in the seventies as a result of the continuous increase in traffic demand and the inability of the existing facilities to match transport demand growth. Until early 1974, transport policy and planning was essentially on an ad hoc basis(8). This is not surprising given the short history of modern transport development in Oman, reflected in the fact that Oman's highways network in 1970 consisted of only 10 km of paved roadway and about 1,817 km of tracks graded roads. The Italconsult (1974) commented on this:

> History of road planning in Oman is very short and it is difficult to formulate a firmly based comment. One major point is that until 1973 decisions as to building new roads have been reached without specific economic studies. The reason for this may be the urgent need to proceed without delay to implementation of the major road projects(4).

The first step towards transport planning was taken in 1973 when the Ministry of Communication made an agreement with Italconsult to carry out the first transport study (Oman Transport Survey). The basic aim of the Oman Transport Survey was to provide the government with a comprehensive study of the transportation system with a view to recommending appropriate actions as to new infrastructures investments as well as organisational and institutional measures. Since then, many individual road projects and a few non-comprehensive transport studies were conducted at both the national and regional levels.

### 4.2.2 - *PLANNING ORGANISATIONS*

Physical planning in Oman has been undertaken in the context of extremely rapid change since 1970. Responsibility for planning, land allocation and provision of infrastructure services has, over the years, been divided between a number of government agencies. In recognition of the difficulties experienced in the past by these various agencies in preparing plans for development in the Sultanate, the Supreme Committee for Town Planning was set up under Royal Decree 27/85, to establish general policy for town planning and to set up planning policies related to the authority responsible for physical planning(9).

Transport planning, particularly the design of road network, is fundamental in planning an area and determining its character. A number of government agencies have responsibilities for various aspects of development of the road network in Oman. The Ministry of Housing is responsible for setting the general corridors for roads and streets in regional studies, town structure and local plans. The Ministry of Communication is the authority responsible for the design and construction of primary roads. Royal Oman police is responsible for traffic and vehicle regulations and control. Other agencies share responsibility for other roads and primary streets in various parts of the Sultanate. These include the Muscat Municipality, Dhofar Municipality, Ministry of Regional Municipalities and Sohar Development Office. Furthermore, other national agencies can build roads for their own uses, e.g. Ministry of Defence and Petroleum Development Oman.

In the case of the Muscat Area road network, the Ministry of Communication was the agency with overall responsibility for planning, construction and maintenance of all main roads until 1985. Meanwhile the Muscat Municipality was fully responsible for local access roads, parking areas and foot-ways. Thereafter, the overall responsibility of all the road network was undertaken by the Muscat Municipality.

### 4.2.3 -*ROAD PLANNING AND PROJECTS IMPLEMENTATION PROBLEMS*

In the last two decades the buoyant national economy has resulted in the rapid development of the Muscat Area as a commercial, industrial and service centre, and there has been a massive internal and external migration into the Area (see Chapter 2 for further discussion). This rapid population growth placed an increasing burden upon the infrastructure services, therefore, it was necessary to overcome these deficiencies by means of heavy investment.

Since there were no opportunities for waterways or fixed track systems, the government anticipated that the provision of an adequate road network would be an essential first step towards a successful implementation of the new development programmes. Accordingly, a great deal of effort was made by the government to ensure that the development of the Muscat Area road network took full account of existing and future requirements. The Muscat road network did not develop haphazardly; it was controlled and directed through planning programmes. However, the rapid urban growth, among other factors, created the existing deficiencies of the road network. To clarify where the improvements need to be made, it is necessary to discuss these factors in this section as follows: -

4.2.3.1 - LACK OF PLANNING DATA

The volume of the traffic which is and can be expected to make use of the road network in the future is likely to be governed to a great extent by the distribution of the major residential areas, commercial, industrial and service centres. A full census has not yet been carried out in Oman. Since 1970, various estimates of the Muscat Area population have been produced by a number of consultants and most of these estimates were mainly based on on-the-spot survey or calculated from other related sources with weak assumptions. Llewelyn-Davies (1977) shows the procedure in which the population of the Muscat Area was estimated:

> The study is however handicapped by a lack of statistical data. The characteristics of the population in terms of nationality and employment are not known. It is necessary for our planning purposes to arrive at a figure for the Capital Area in 1977. In order to do this, it has been assumed that 60,000 is the correct figure for 1974. Sir Alexander Gibb's figures for sections of the Capital Area have been taken as a starting point, and some survey work carried out to determine the approximate scale of development and settlement of population that has occurred since 1974. In addition, informal official comment has been used to guide the total population.(10)

*Table 4.1* shows some previous estimates of the Muscat Area population by various consultants. It can be seen from the table that the estimates produced in the 1970s for the Muscat Area population in the 1990s were considerably lower than those produced during the 1980s. Llewelyn-Davies Consultant estimated the Muscat Area population in 1977 and 1982. In the 1977 population prediction, the Consultant greatly underestimates the 1985 population, while the 1982 population prediction for 1990 was higher than the recent estimates by Weidleplan Consultant for the Ministry of Housing, (based upon a housing study).

*Table 4.1*: Pervious Population Estimates of the Muscat Area

| Year | Consultant | Base Year | | Design Year | |
|---|---|---|---|---|---|
| | | Year | population | Year | population |
| 1972 | Whitehead (11) | 1972 | 25,000* | --- | --- |
| 1973 | Brain Colquhoun(12) | 1973 | 30,000* | --- | --- |
| 1973 | Italconsult(4) | 1973 | 40,000 | 1995 | 150,000 |
| 1974 | Sir Alexander Gribb(13) | 1974 | 60,000 | 1990 | 190,000 |
| 1976 | The Middle Economic Digest(14) | 1976 | 80,000 | --- | --- |
| 1977 | Llewelyn-Davies(10) | 1977 | 80,000 to 85,000 | 1985 | 116,300 to 157,200 |
| 1982 | Llewelyn-Davies(15) | 1982 | 226,000 | 1990<br>2000 | 443,000<br>686,000 |
| 1989 | Weidleplan(16) | 1989 | 405,278 | 1990<br>2010 | 417,000<br>730,300 |

* Muscat and Muttrah towns population

Although the Muscat Area population estimate was one of the most important goals of the Muscat Area Housing Study (1989), the methodology of estimation was doomed from the start due to the sampling technique adopted. The consultants distributed and collected the questionnaires through selected schools covering the whole Muscat Area. This technique did not include households having no children attending school. Therefore, the consultant had to depend on unreliable assumptions to reach the total population. The following steps of the calculation were followed as stated by the Weidleplan Consultant in the Muscat Housing Study (1989) :-

(1) The figures given in the land-use and Building Survey have been cleaned up by deducting the units not occupied or under construction.

(2) Assuming that there is a certain percentage of misuse[non-housing use probably is the correct word](offices etc.) in the housing stock not identified by the survey team the number of residential flats has been reduced by deducting 12% of the total number due to unidentified misuse [non-housing use]. Since merely the Greater Muttrah area is affected severely, only for flats found there the a.m. share has been deducted. The share was ascertained from different angles(i.e. survey teams, real estate agents ...).

(3) During the Household Survey occupancy rates were recorded on super block-level. Since the sample does not incorporate households having no children attending school the figures had to be adjusted. Presuming a share of 15% not covered by the survey the overall occupancy rate was modified as follows.

Taking into consideration the household size distribution as given in the Socio-Demographic Survey 1984 it is postulated that the households not covered are mainly of smaller size (i.e. 1 to 5 persons). Therefore the overall occupancy rate was recalculated by filling up the household size groups according to the distribution of the Socio-Demographic Survey. Considering this modified structure the adjusted occupancy rate amounts to 7.7 persons per dwelling unit corresponding to a 9% reduction of the Household Survey result (8.46). The results per super block have been modified accordingly.

(4) Multiplying the number of dwelling units (per super-block and dwelling type) used for residential purposes with the respective occupancy rate number of population living in the residential housing stock of the Muscat Area can be calculated.

(5) During the Land-use and Building Survey and the Labour Accommodation Survey workers living in bachelor accommodation, dormitories and labour camps were counted separately. Hence they have to be added to the residential population to achieve the total population number within the Muscat Area.

(6) Finally the number of people living in villages and settlements outside the boundaries of the block-system has to be added.

(7) People living in restricted areas are not included. Thus the final estimation of the population living in the Muscat Area (outside restricted areas) comes out at 405,000 people in mid 1989.

As seen in *Chapter 2*, there is a significant variation in the household size according to household location and nationality. This study Home Interview also found that 24 per cent of all households have 1 to 3 persons, 48 per cent have 4 to 7 persons and 28 per cent have more than 7 persons. These figures differ significantly when the Omani and non-Omani are considered. Thus, it can be said that the consultant's overall occupancy rate of 7.7 persons is overestimated and unlikely to represent the population per super block accurately for two reasons: Firstly, schools are not equally distributed among the super blocks in terms of their level and type (Arabic, non-Arabic). The consultants' Household Survey high result of 8.46 overall occupancy rate indicates that most of the questionnaires were distributed among preparatory and secondary schools. This could have caused the error as a household having a student in high school level is more likely to be a household with older parents, and hence many members. Furthermore, a household may unnecessarily fill in the same questionnaire more than once if there is more than one student in the household. Secondly, the household sample selection does not consider the differences between Omani and non-Omani households. Omani and non-Omani household differ significantly in their size (section 2.4). Therefore, the proportion of Omani and non-Omani households in the sample size will have great impact on the average occupancy rate per household. In addition, Non-Arabic schools are concentrated in specific areas (Qaboos City, Qurm, Darsait), therefore, the distribution method adopted is unlikely to achieve a fair share between Omani and non-Omani households.

The lack of population census is exacerbated by the lack of compatibility and agreement in the population estimates, which confuses planning agencies. In the Final Report of the Muscat Area Structure Plan, Muscat Municipality commented on the future population estimates by this statement:-

> The report states that population number in the Muscat Area will amount to 730,000 souls in the year 2010, whereas the estimates of the Directorate General for Statistics of the Development Council Technical Secretariat show that it will be 500,000 in 2010. It is obvious that the difference between the two estimates is very great (230,000).

Furthermore, the Ministry of Housing criticised the consultant for ignoring its own population projection for the Muscat Area of 830,000 in the year 2010 in the Muscat Area Housing Study (1991), while in the draft report of the Muscat Area Structure Plan it used the population projection of 730,000 for the Muscat Area in year 2010. In fact, it is also used in the final report of the Muscat Area Structure Plan without a convincing justification.

Transportation and other related data are not any better. There is a lack of data-collection system. The necessary data, such as characteristics of travel, employment, land-use, household income and car ownership are not always readily available or reliable. Therefore, planning data have to be collected by the consultants themselves within the time and budget limits of their contracts. The problem of the deficiency in the basic traffic counting and associated traffic data collection has been addressed by many consultants. Dar Al-Handasah Consultant wrote the following about traffic data collection in the Second Highway Maintenance Project (1986 - 1990): -

> All traffic counting and other traffic data collection throughout the Sultanate, continue to be the responsibility of the staff of the small Directorate General of Roads Traffic Section. This policy, which has been in force for the past ten years, has never operated successfully. Staff and equipment have been totally inadequate at all times during both the previous Highway Master Plan study and the present study. In fact, the enumerator staff situation (6 enumerators to cover the entire Sultanate) is now worse than it was three years ago, and all efforts to obtain adequate and suitable field and office staff from the Ministry have failed(3).

4.2.3.2 - LACK OF QUALIFIED STAFF

In any kind of problem-solving exercise, the choice of method is greatly influenced by how the problem is perceived and defined at the outset, for this determines both the scope and character of the analysis that follows. In the field of urban transport, it is common knowledge that problems are perceived and presented in a variety of ways by different people and agencies. Such perceptions vary according, among other things, to the analysts' interests, institutional allegiances, and political ideologies, and educational and training backgrounds. The lack of compatibility and agreement among many of these perceptions, as well as the partial coverage of the field that some of them provide, have contributed considerably to the problems of urban transport planning and transport facility provision(17).

The quality of planning obviously depends on the quality of the planners. In the past, there was a gap between the difficulty of the job and the capacity of Omani professionals to do it. Thus, attempts were made by the government to narrow this gap by concentrating on education and professional training for Omani. Meanwhile, the government had to depend on expatriates in the early years of the development in order to implement the development programmes of the country; realistically, however, the gap was not closed easily or quickly, particularly, before 1970 when the number of schools in Oman was limited to three primary schools, with 909 male students(18).

Until relatively recently, transport planning in Oman was based in the nature of one-way communication of planning expertise in which the concerned ministry was excessively dependent upon foreign consultants in their efforts to resolve transport problems. The consequence was that some of their recommendations were too ambitious and often impossible to implement, as was the case with many developing countries. The World Bank (1986) referred to this as follows:

> Confronted with the need to find solutions to urban transport problems, both official sources of finance and private sector consultants tend to suggest large capital-intensive projects. These are commercially attractive to the suppliers of equipment and services and tempting to developing countries that may lack the experience to appreciate the full implications of such projects(19).

4.2.3.3 - POOR PLANNING TECHNIQUES AND STUDY OUTCOME

The urban transport problem is an integral element of a much broader collection of problems and issues associated with city growth and hence should not be considered in isolation. Transport, and particularly the road network, plays an essential role in the life of any community today. A good road network is the result of sound planning and it is now being recognised that transport planning cannot be, and must not be, isolated from other city growth issues such as land use planning(20).

Since transport planning is an integral part of the whole process of planning, it is important that it is undertaken on a broad scale, encompassing the whole area. It is not enough to consider roads or public transport alone, nor to consider an urban area in isolation from its hinterland. Transport planning must take into account the interaction of all means of movement and the effects of different levels of restraint upon the overall movement pattern. Furthermore, transport planning is not an occasional task; it is a continuing activity, calling for regular data collection, monitoring of programmes and predictions, updating and modification of plans, and implementation(21).

Such a comprehensive transport study has not yet been carried out in Oman due to the fact that over the years the responsibility for transport planning, construction and maintenance has been divided between a number of government agencies (see section 4.2.2). Therefore, the previous transport studies were unlikely to cover all aspects of the transport system as some times they were limited to individual government agency field of interest or responsibility (see Chapter 1). However, despite the above mentioned factors, the studies themselves were technically weak. They failed to predict and control the rapid urban development of the Muscat Area and to provide acceptable solutions for transport demand to match the existing and future development. Furthermore, some road improvement schemes were too ambitious, and cost-effective solutions were not considered.

In the absence of detailed methodologies and policies best suited to the conditions of the developing countries, methods designed for developed countries and universal policies were applied in the previous Muscat Area transport studies within the time and budget limits of the consultants' contracts, without careful consideration to the differences in social, economic, and topographical conditions. Dar Al-Handasah consultants in the Capital Area Transport Study (1985/87) applied the "urban transport planning modelling process" which is a part of the "urban transport planning process". Such a uniform process consists of the four-step sequential models of trip generation, trip distribution, modal split, and traffic assignment. Due to the lack of data to fuel these sophisticated models, the study was dominated by data collection to meet the demand of very data-hungry models that have been criticised frequently by many reviewers for their full application in the developing countries as it is stated by Thomson (1986) :-

> Experience in the developed countries with the models generally used has been far from satisfactory. In developing countries with much more

uncertainty concerning future growth, income and land use, these models seem even less appropriate[21].

It is worth mentioning that the objectives of the Capital Area Transport Study (1985/87) were:- (1) - To develop a strategic traffic model which could be used to test network proposals (mainly the road network proposed in the Capital Area Structure Plan, by Llewelyn-Davies Consultant in 1982) over short, medium and long term planning ( approximately 5, 10 and 20+ years respectively), and (2) - To establish an efficient road and traffic data collection and processing system. Because the study was limited to the above aspects, transport-related problems were addressed, and further studies were suggested by the consultant towards achieving an effective transport system for the Muscat Area. These studies include: traffic management, road safety, parking and public transport study. Unfortunately, these suggestions are, on the whole, not as yet considered.

In practice, transportation models are developed for two reasons: the first one is to describe (understand) the phenomena we model; the second is to utilise models in some practical applications, mostly in travel forecasts and policy analysis[22]. Therefore, the main purpose of developing the traffic model was to enable the Muscat Municipality to test, assess and evaluate different future scenarios. Largely these scenarios consist of different proposals for extending or modifying the existing highway network. Dar Al-Handasah consultants, therefore, requested the Municipality to establish a Transport and Traffic Planning Unit with professional staff within the Projects Department to enable the Municipality to apply the models when necessary, but the request failed and the traffic model is shelved due to the lack of professional staff.

#### 4.2.3.4 - LACK OF PROJECT IMPLEMENTATION

As mentioned earlier, the growth of the Muscat Area and its road network is determined by the mountainous terrain. The consequent relatively high density development in the flat land space and compact urban area are reflected in a very high road construction cost. This problem is so marked in the older areas, such as Muttrah, Muscat and Ruwi, where parts of the built-up areas create significant constraints on major improvements on existing roads and construction of new major roads.

One of the key question that needs to be answered in any successful transport planning is how much should be spent on improving the system? At first, the answer was unclear, but since 1976 the answer is clear through a series of Five-Year Development Plans, where the total investment programmes for major projects, including transport expenditure, were set up clearly by the government through the Development Council. However, the planning consultants do not seem to have a feeling for what is financially feasible, or else they would wish to push their case regardless. Either way, many plans have been shelved for lack of funds because of priority scheduling of most of them were not programmed according to the available funds, (see Chapter 5 for more detail).

The lack of Omanis trained in traffic engineering and transport planning, and the employment of inexperienced expatriates, mostly from developing countries, contributed to the failure of some previous efforts. Furthermore, the expatriates, to some extent, were unable to clearly present the dimensions of the transport problems and future demand for decision makers and financial agencies. This is the case in many Middle East cities. For instance, in Amman:

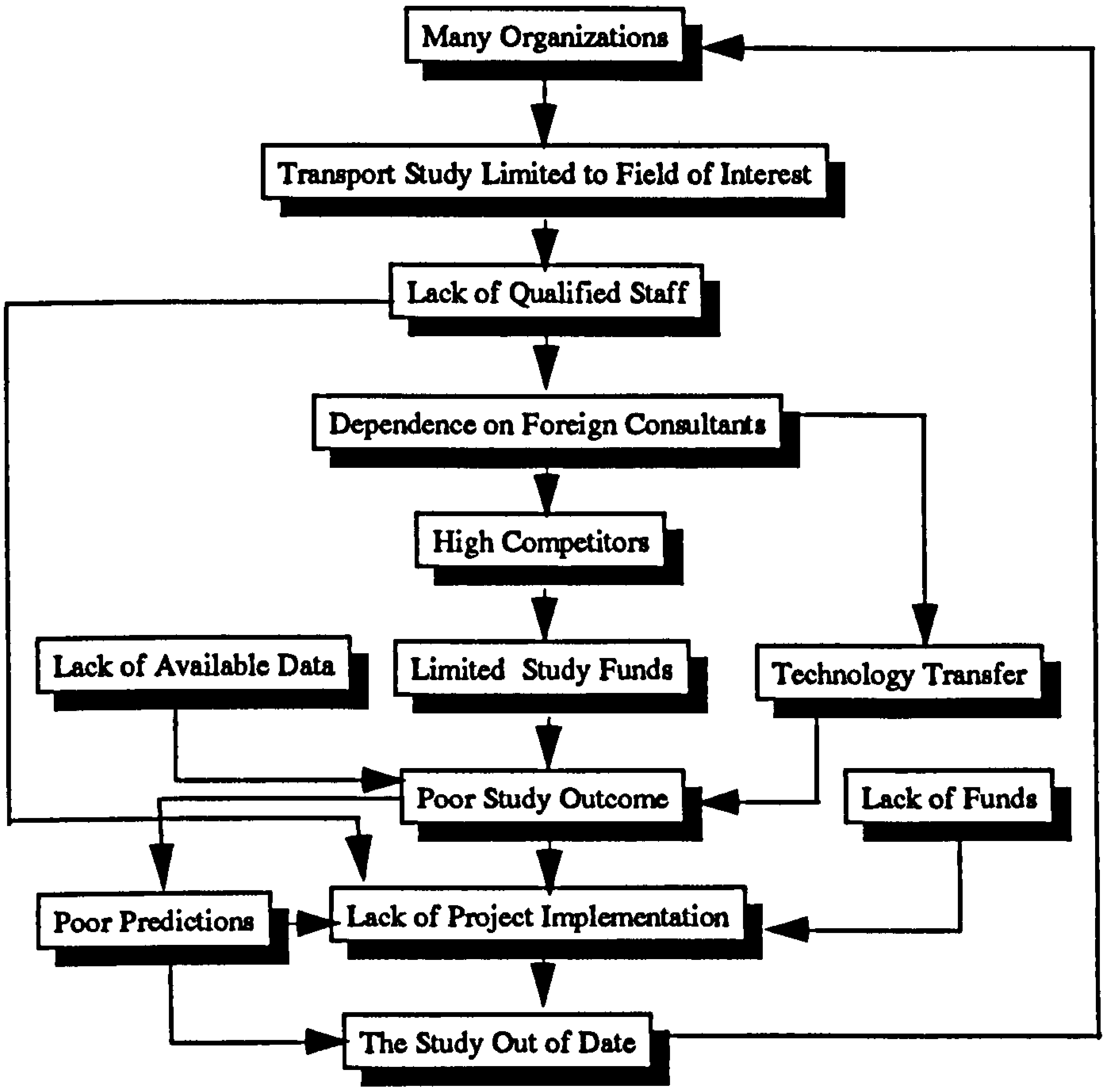
> One of the great impediments to progress has been the lack of Jordanians trained in traffic engineering and transport planning, and the employment of expatriates from developed countries has not been practised widely as a means of overcoming this deficiency . . . . .Perhaps the biggest obstacle to developing a properly integrated transport system in Amman Region is the dispersal of function among a variety of public authorities, without a powerful co-ordinating control body(23).

In Muscat, the lack of project implementation is also exacerbated by the lack of co-ordination between the agencies responsible for urban development, Weidleplan Consultant (1991) commented on this:

> The responsibilities for urban development are dispersed over a multitude of ministries each following, more or less, their own development strategies and specific priorities(24).

*Figure 4.2* illustrates the factors that effecting transport planning and projects implementation in the Muscat Area.

*Figure 4.2:* **Simplified diagram of the factors affecting transport planning and projects implementation in the Muscat Area**




## 4.3: MUSCAT AREA EXISTING ROAD NETWORK

### 4.3.1 - *GENERAL*

The Muscat Area road network has been expanded and extended very rapidly in the last two decades, mainly in line with the development of the land use system. The topography of the Muscat Area (Chapter 2), coupled with the channel development along a series of valleys, large bowls and a narrow coastal plain indicated a linear major road pattern with access roads connected to them at several points.

The main strategic weakness of the existing highway network is the existence of only a single east-west corridor (Sultan Qaboos Road) in the middle of the Muscat

Area. Furthermore, the alternative routes that exist to the immediate east and west of this single corridor are of more local than strategic nature. The 1982 Capital Area Structure Plan (CASP)(15) also recognised this weakness and proposed a "Southern Corridor" running parallel to the existing Sultan Qaboos Road from Burg A'Sahwa Roundabout to Wadi Adai. No substantial progress has so far been made towards the establishment of this facility.

In the early 1980s, however, several roads were built in accordance with the proposed network in the Capital Area Structure Plan. Other links and interchanges were also built, not necessarily related to the CASP proposals. A substantial part of the new roads construction was completed in 1985, including the provision of additional capacity along the existing Qaboos Road, in terms of flyovers, extra lanes and service roads. However, no major increase in the highway capacity has taken place since 1985. There are a number of other proposed highway projects of both strategic and local natures which have been proposed by either the Capital Area Structure Plan or other studies. Some of these projects have reached the final design stage. A detailed description of these proposals is given in Chapter 5.

Precise official historical registration data for road length in the Muscat Area are not available as records are maintained only for the entire country, (section 4.1). Weidleplan Consultant, in 1991, estimated the overall length of asphalt roads in the Muscat Area at 720 km(24). *Figure 4.3* illustrates the road network.

### 4.3.2 - *REGIONAL ROADS*

As mentioned earlier (Chapter 2), the topographical aspects have influenced the shape of the Muscat Area road network and limited its access to the rest of the country and internationally via Al-Batinah Road (dual carriageway) to the west, Nizwa Road (single carriageway) to the south-west and Al-Hajar Road (single carriageway) to the south-east. Al-Batinah Road (highway) which passes through the whole of northern Oman connects various coastal towns and the United Arab Emirates to Muscat. Nizwa Road through which the interior and other regions of the

Sultanate connects with Muscat. Al-Hajar Road links the Muscat Area with a small populated area of Wilayat Quriyat. These roads are all asphalted and generally in good condition. They are heavily used by commuters to the Muscat Area. A number of sub-regional access roads exist, but all of them are earth-roads and of limited importance, (only to small villages around the Muscat Area).

4.3.3 - *URBAN ROAD NETWORK*

The urban road network is mostly composed of the Sultan Qaboos Highway and its offshoots on either side to major residential areas. It was built in the early 1970s and most of the development is located along this road. The route is now constructed for most parts as a dual two-lane to three-lane carriageway with flyover roundabout intersections at some parts. It runs east-west, linking together the Muscat Area and forming the start of the national road network to Al-Batinah, the interior and Salalah. Because of Muscat's linear configuration, Qaboos highway carries most long and short distance trips within the Muscat Area, in addition to the regional traffic entering the Muscat Area.

The road pattern in Greater Muttrah is improved with approaches from Sultan Qaboos highway and Qurm-Darsiat highway supported by the network of Ruwi High Street, Baladiya Road, Al-Jaame Road, Corniche Road, Wadi Kabir-Muscat-Ruwi loop, MBD Road, etc. Various residential areas in Boashar have their own local level circulation roads, e.g. in Qaboos City, Al-khuwair, Shati Al-Qurum, Information city, Wattayah and Qurm Heights. In new areas of Seeb, the road system is well developed and with the existing/future regional linkages, large areas will be connected. Residential access roads in the Seeb municipality are not surfaced and for the most part little better than tracks, with the exception of some residential areas in Seeb town and Al-Khod. Development in Al-Amarat is mainly along Hajar Road, and the access to this road from residential and commercial areas is by levelled gravel tracks.

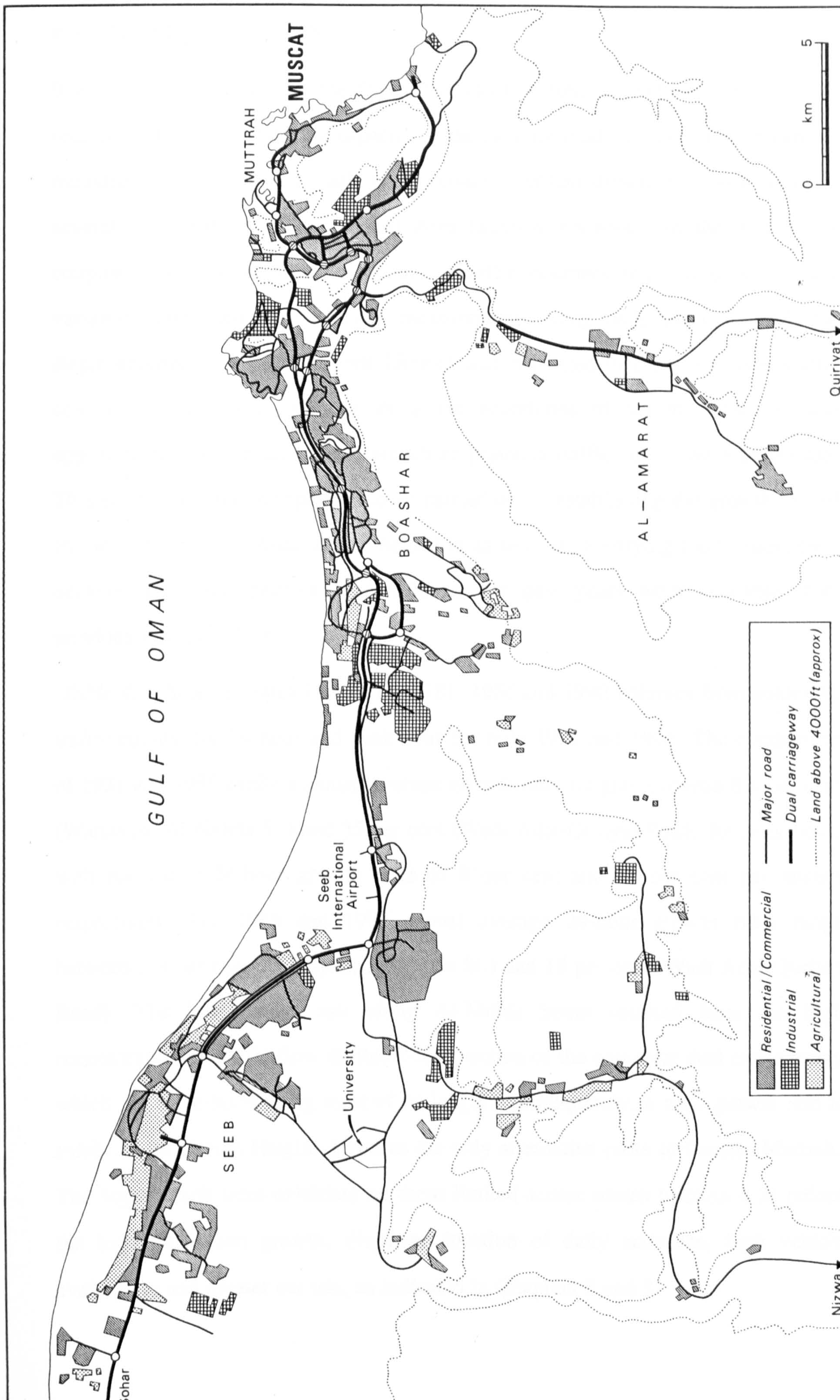



*Figure 4.3:* Muscat area existing road network

## 4.4 - TRAFFIC VOLUMES

It is important to appreciate the characteristics of persons and vehicle movements in relation to the traffic carrying capacity of the existing road network. The researcher intended to include an automatic traffic count to obtain directional traffic flow on several key locations of the Muscat Area highway network, but the time factor coupled with lack of suitable automatic traffic counters (e.g. to obtain hourly variation) prevented these planned measurements being undertaken. Instead, the Representative of BP Middle East Limited was requested to carry out some traffic counts on a few key locations along the boundaries of the municipalities and approximately on the same locations where previous traffic counts were conducted. This enabled a direct comparison to be carried out in establishing the growth rate of traffic in the Muscat Area. It also helped in as well as identifying traffic movement between the municipalities. The volumes for past years were available from previous studies(3, 25, 26)

*Table 4.2* shows a comparison of the 1981, 1986 and 1990 volumes from automatic traffic counts, for 24-hour and peak-hour for only 1981 and 1986. The comparison of 1981 and 1986 exhibits annual average growth rates ranging between 8.4 per cent (Wattayah, Al-Nahda St.) and 35 per cent (Wadi Adai-Quriyat Road) for peak-hour, with equivalent 24-hour growth rates of 8 per cent and 18 per cent per annum respectively. For 1986 and 1990 annual average 24-hour growth rates range between 5.8 per cent (Wattayah, Al-Nahda St.) and 16 per cent (Wadi Adai-Quriyat Road). The low growth rate along Al-Nahda Street resulted from the high concentration of traffic flow on this 2-lane section of the east-west dual carriageway which has three-lanes along most of its length. Consequently, a high growth rate is exhibited on Qurum Heights Street as the only alternative route to Greater Muttrah. The high growth rates exhibited on these limited access routes (section 4.3) reflect the high population growth, dispersed location of daily activities, high vehicle availability and greater car use, as indicated in Chapters 2 and 3.

*Table 4.2 :* A comparison of Traffic Flow on Key Locations (1981, 1986 and 1990)

| Location | Station No. | Direction | 24-Hour Average Weekday Traffic Flow | | | 24-hour Traffic Growth Rate (% p. a.) | | Peak-Hour Average Weekday Traffic Flow* | | P.H. Traffic G. Rate |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1981 | 1986 | 1990 | 81-86 | 86-90 | 1981 | 1986 | (%p.a.) |
| Wadi Adai - Quriyat Road | 6 | Northbound | (3400) | 7082 | 11699 | 17.7 | 16.3 | (302) | 1185 | 35.5 |
| | 6 | Southbound | (3542) | 7379 | 12249 | 17.7 | 16.5 | (224) | 882 | 35.5 |
| | 6 | Two-Way | 6942 | 14461 | 23948 | 17.7 | 16.4 | 526 | 2067 | 35.5 |
| Qurm hights St. | 4 | Eastbound | -- | 17549 | 24779 | -- | 10.3 | -- | 1489 | -- |
| Wattayah | 5 | Eastbound | 23241 | 32729 | 40583 | 7.9 | 6.0 | 1779 | 2561 | 8.4 |
| Total | 4+5 | Eastbound | 23241 | 50278 | 65362 | 18.7 | 6.8 | 1779 | 4050 | 20.1 |
| Qurm hights St. | 4 | Westbound | -- | 16490 | 23481 | -- | 10.6 | -- | 1517 | -- |
| Wattayah | 5 | Westbound | 23260 | 30207 | 38342 | 6.0 | 5.8 | 1733 | 2556 | 9.0 |
| Total | 4+5 | Westbound | 23260 | 46697 | 61823 | 16.8 | 7.3 | 1733 | 4073 | 20.9 |
| Qurm hights St. | 4 | Two-Way | -- | 34039 | 48260 | -- | 9.4 | -- | -- | -- |
| Wattayah | 5 | Two-Way | 45501 | 62936 | 78925 | 7.0 | 5.8 | 3512 | 5117 | 8.7 |
| Adhuba, Qaboos Road | 3 | Eastbound | 11081 | 19671 | 32103 | 13.6 | 15.8 | 932 | 1718 | 14.6 |
| | 3 | Westbound | 10904 | 20005 | 32408 | 14.4 | 15.5 | 795 | 1307 | 12.9 |
| | 3 | Two-Way | 21985 | 39676 | 64511 | 14.0 | 15.7 | 1727 | 3088 | 13.8 |
| Nizwa Road, Muscat Area Boundary | 2 | Northbound | (1987) | 3358 | 4399 | 11.0 | 7.0 | -- | 351 | -- |
| | 2 | Southbound | (1929) | 3315 | 4340 | 11.5 | 7.0 | -- | 322 | -- |
| | 2 | Two-Way | 3916 | 6673 | 8739 | 11.3 | 7.0 | -- | 673 | -- |
| Batinah Road Muscat Area Boundary | 1 | Eastbound | 3869 | 5808 | 7864 | 8.5 | 7.8 | -- | 612 | -- |
| | 1 | Westbound | 3717 | 5815 | 7710 | 9.4 | 7.3 | -- | 700 | -- |
| | 1 | Two-Way | 7586 | 11623 | 15574 | 9.0 | 7.6 | -- | 1312 | -- |

Key: * Either Morning Peak Hour or Evening Peak Hour, whichever is greatest
() Estimated directional flow from Two-way total flow

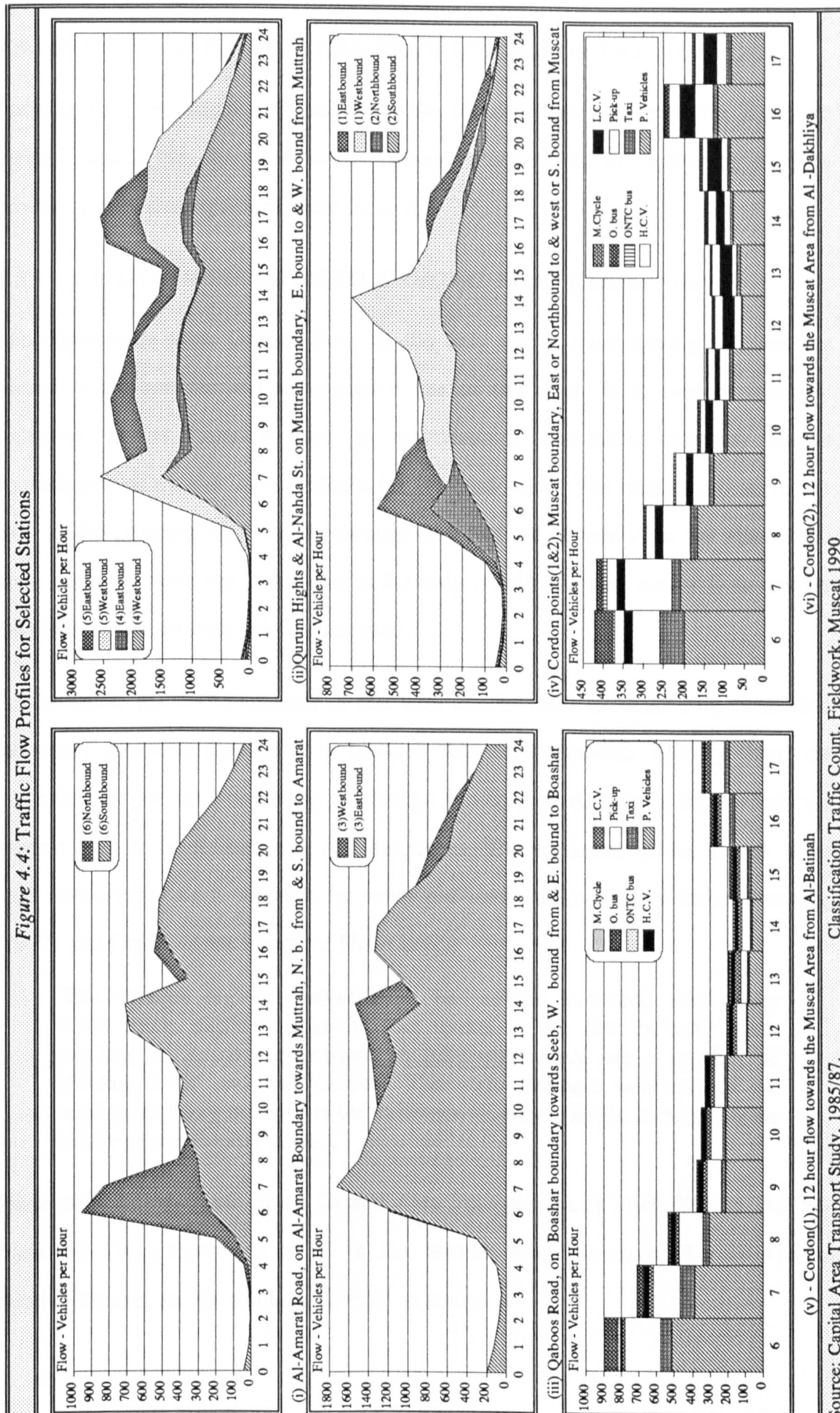
In Chapter 3, the variation of the 7869 internal person trips, and the hourly variation of the 812 vehicle drivers by trip destination purpose have been discussed. In order to explore the pattern of hourly traffic flow in relation to main access routes, the 1986 traffic volumes were adopted to demonstrate variation of traffic flows during a typical weekday, as illustrated in a series of profiles in *figure 4.4 (i) through (iv).* The variation of 12-hour (0600 - 1800) traffic flow by vehicle type entered the Muscat Area during the Roadside Interview (fieldwork 1990) is illustrated also in *figure 4.4 (v & vi).*

As seen in *figure 4.4*, the analysis of 24-hour automatic traffic counts for 1986 shows that traffic flow generally builds up after 6:00 a.m. and starts declining after 6:00 p.m. A general drop in traffic flows is noted between 2:00 p.m. and 4.00 p.m. Both morning and afternoon/evening are evident in all cases. The proportion of peak- hour flow ranges between 6.5 per cent in the Qaboos Road (Adhuba, Boashar boundary with Seeb) and 16.7 per cent, in the Wadi Adai Quriyat Road, of the total daily traffic, with an overall peak-hour weighted average of 9.5 per cent. These figures differ slightly from those shown in the hourly variation of personal travel, (Chapter 3), but given the difference in type of trips, period of the survey and representation method, the two groups of figures show a remarkable consistency.

*Figure 4.4 (v & vi)* illustrates the hourly variation of inbound traffic flow in 12 hours at each of interviewing cordon point. There are two peaks, during the period of the 12 hours of daylight; the morning peak hours on Nizwa Road, occur between 6:00 a.m. and 7:00 a.m. (16%), and the evening peak hours between 4:00 p.m. and 5:00 p.m. (9 %). For Al-Batinah Road, the morning peak hour also occurs between 6:00 a.m. and 7:00 a.m. (20%), and the evening peak hours between 5:00 p.m. and 6:00 p.m. (8%). Generally inbound traffic flow towards the Muscat Area builds up after 5:00 a.m. and starts declining after 6:00 a.m., as seen *figure 4.4 (iv)*.

When the characteristics of external travel in terms of vehicle type are investigated, private vehicles emerge as the predominant mode of travel throughout the day. They account for over 50 per cent of peak hours traffic flow on Nizwa Road and 56 per cent on Al-Batinah Road. On Nizwa Road, the peak for pick-up travel occurs in the morning between 7:00 a.m. and 8:00 a.m., and it accounts for nearly three times the pick-up average hourly totals. On Al-Batinah, the peak for pick-up travel occurs in the morning, and it accounts for more than twice the pick-up average hourly totals. The peak hour for taxi travel occurs during morning peak hours on the Nizwa Road, and accounts for 36 per cent of all taxi trips, while on Al-Batinah Road it occurs between 7:00 a.m. and 8:00 a.m. and accounts for 23 per cent. Other modes of travel are fairly spaced throughout the day.

*Figure 4.4:* Traffic Flow Profiles for Selected Stations




Source: Capital Area Transport Study, 1985/87. Classification Traffic Count, Fieldwork, Muscat 1990

## 4.5 - PRESENT AND POTENTIAL DEFICIENCIES OF THE NETWORK

Looking into the present deficiencies of the Muscat Area road network, there are several factors that have led to the present situation. In the following sections provide a brief description of these factors: -

### 4.5.1 - *LACK OF ALTERNATIVE TO REGIONAL ROAD* (Qaboos Road)

The dependence upon Qaboos Road as the only traffic route linking together the Muscat Area has resulted in excessive use of the road. It is evident that any reduction in its capacity (due to maintenance, accidents, closures) causes considerable delay and inconvenience for the road users. The road has to serve not only as the principal traffic route through much of the Muscat Area but also as the main route for taxis and buses and as the only means of direct access to numerous developed areas on both sides of the road.

Furthermore, the traffic capacity of this vital arterial route is reduced by permitting too many access arrangements in between the main junctions. Already there are indications of the road becoming overloaded and congested, causing trips within the Muscat Area to be tedious long and dangerous. The weakness of the Muscat Area road network has been observed by many previous studies such as Oman Planning (1977) and Capital Area Structure Plan (1982).

> "The existing highway network ... has certain structural weaknesses which cause traffic to take indirect routes or use low capacity roads resulting in serious congestion. In particular, there are a number of 'missing links' and 'bottlenecks'. The main strategic weakness of the existing highway network is the existence of only a single corridor in the middle of the Capital Area..."

These observations made in the Capital Area Transport study (1985/87) by Dar Al-Handasah Consultants and stated in the Muscat Area Structure Plan (1991) by Weidleplan are, on the whole, still valid to today.

4.5.2 - *UNRECOGNISABLE ROAD HIERARCHY* (Mixed Use of Urban Roads)

Most urban roads have many functions besides providing passage for moving vehicles and pedestrians. These functions may be broadly categorised as environmental, access, local traffic and through traffic. Not all of these need to be accommodated in any particular road but, for the purposes of planning and design, the functions that a road should cater for need to be identified and relevant priorities assigned to them. Typically, conflicts arise when a road cannot accommodate the competing demands made upon it. Sometimes it is simply a lack of capacity at a certain time of the day. Sometimes the problems are related to particular activities, such as shopping, but often they are caused by a whole range of conflicting uses and the impacts which they have on one another(27).

In the case of the Muscat Area, a clear, readily recognisable road network hierarchy does not exist. Not everywhere is there a separation between fast-moving through traffic and slower, more erratic area ("local") traffic. Frequently, smaller sections of the three-lane Qaboos highway double up as inner-city road link, are used for road-side parking, or are subject to frequent jaywalking(28).

The indeterminate hierarchy of the Muscat Area road network might due to three factors: the lack of traffic management measures, insufficient investment in transport facilities, and unbalanced pattern of land-use and distribution of people in relation to the land use development. However, it is important to determine the Muscat Area roads hierarchical functions and to see which of the various demands should be given priority, taking account of the most appropriate role for the road in question and its relationship with other roads in the area.

4.5.3 - *INADEQUATE ROAD JUNCTIONS CAPACITY*

The capacity of an urban road network usually depends on the operation of its junctions. The recent development of the city network (1984/85) to cope with the increase in traffic volume, was not accompanied by further improvement in road junctions, except in the east-west corridor. Only few but important junctions are traffic light controlled. However, in many cases the junction is not laid out with left/right turn lanes, therefore the resulting capacity is not adequate for the traffic and long waiting queues evolve.

Most of the signalised junctions are operated with four-phase system, with all running movements assigned in separate phases. The total cycle length varies between 120 to 200 seconds (fixed all day). Most of the signalised urban intersections are individually operated, and where controlled there is insufficient signal co-ordination either on the arterial level or on the area-wide basis. The signal plans do not take into account the different traffic flows in individual directions at different times of day or days of the week. Poor traffic operations usually result from such an arrangement; especially during the peak hours. As a result, some of the traffic lights were stopped from operating, ( e.g. on the Al-Jaame Road, Saif bin Sultan Street, Boashar Road, etc.), and replaced by police officers to control traffic movements (*see plate 4.1*). The Weidleplan Consultant (1990) described the condition of the traffic-lights controlled junctions as " Where traffic lights are used, they are frequently not co-ordinated, leading to congestion(29)".

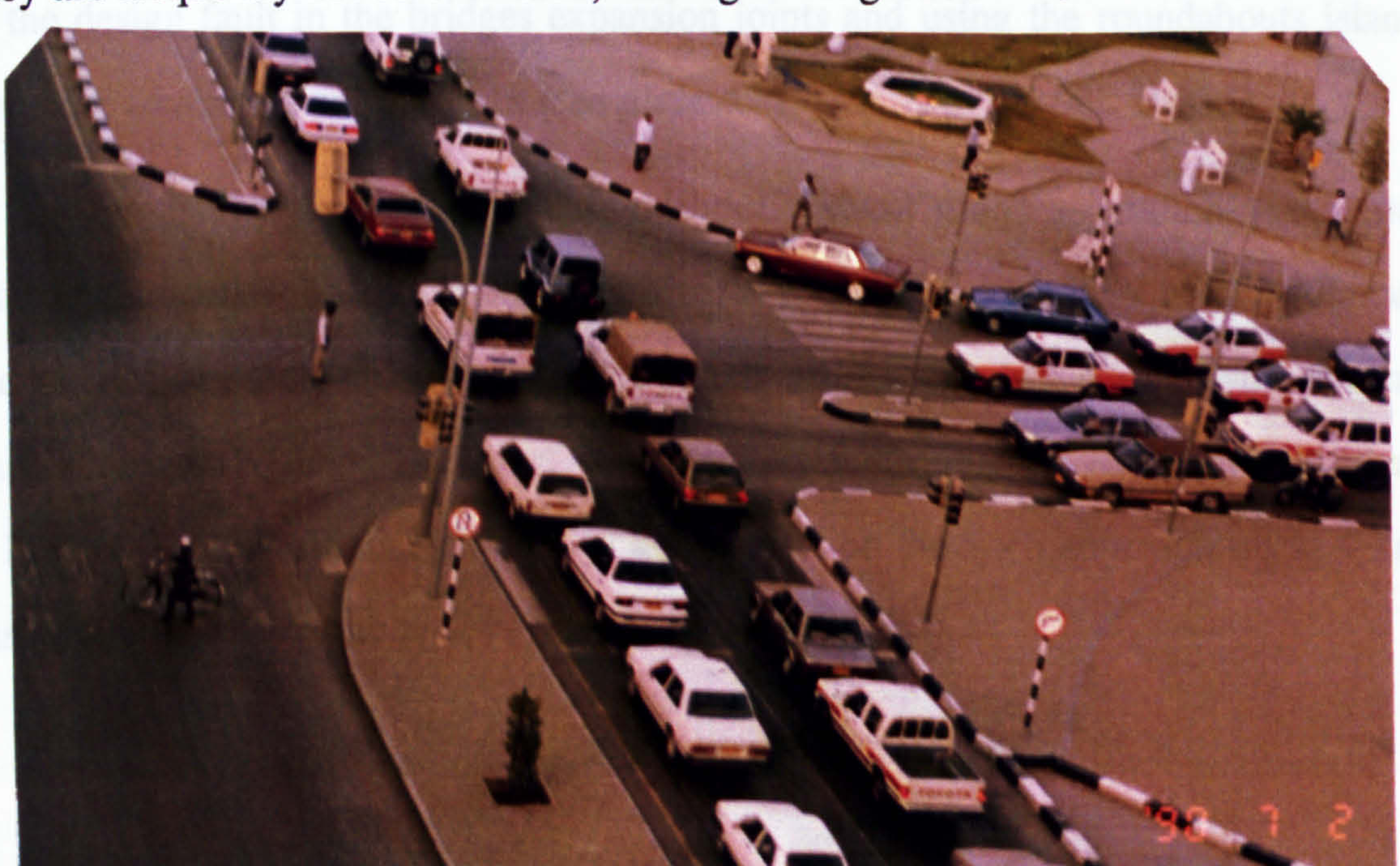


*Plate 4.1:* Traffic Control and Movements on Al-Jaame Street

Roundabouts are generally laid out with two lanes. Due to normal driving behaviour, only one lane is really used, so that the capacity during peak hours is determined by one lane, with the exception of Sultan Qaboos Highway. As mentioned earlier, Qaboos Highway, was constructed for the most part as a dual two-lane carriageway with roundabout intersections. Because of the high traffic demand the road is being upgraded to a dual three-lane carriageway from Wattayah Roundabout to Burg A'Sahwa Roundabout, and with flyovers at Qurum, Al-Khuwair, Boashar and Adhuba Roundabouts.

There is no doubt that the upgraded roundabout intersections of the road into flyover have a great impact on facilitating the continuous traffic flow and easing traffic jams on the roads coming from different directions. When the right/left traffic movement is more than the continuous traffic flow, the use of flyover alone is unlikely to be an adequate mechanism; the result is that severe congestion occurs on many roundabout intersections with flyovers, such as on Al-Khuwair, Wadi Adi, Hamriya and Ruwi Roundabout (*see Plate 4.2*). Congestion is also exacerbated by the banning of commercial vehicles over 3 tonnes from using the flyovers because of the design fault in the bridges expansion joints and using the roundabouts island fence for advertisement purposes (*see plate 4.3*).

At the same time, the use of the roundabout without grade separation within the road system causes for bottlenecks, particularly on those with high traffic volumes and unbalanced traffic demand between their arms. This is the case with several roundabouts on Qaboos Highway, where considerable traffic congestion is evident at Burg A'Sahwa Roundabout and back-up traffic on the Seeb approach up to 4 km during the morning peak hours[30].

In order to enable this traffic from Seeb to enter the roundabout, the police are required to control and to stop the circulating traffic on the roundabout between 7 and 8 each working day morning. Generally, localised traffic congestion is also evident at certain junctions where insufficient capacity or control of traffic exists in relation to the capacity of the roads leading into the junction.

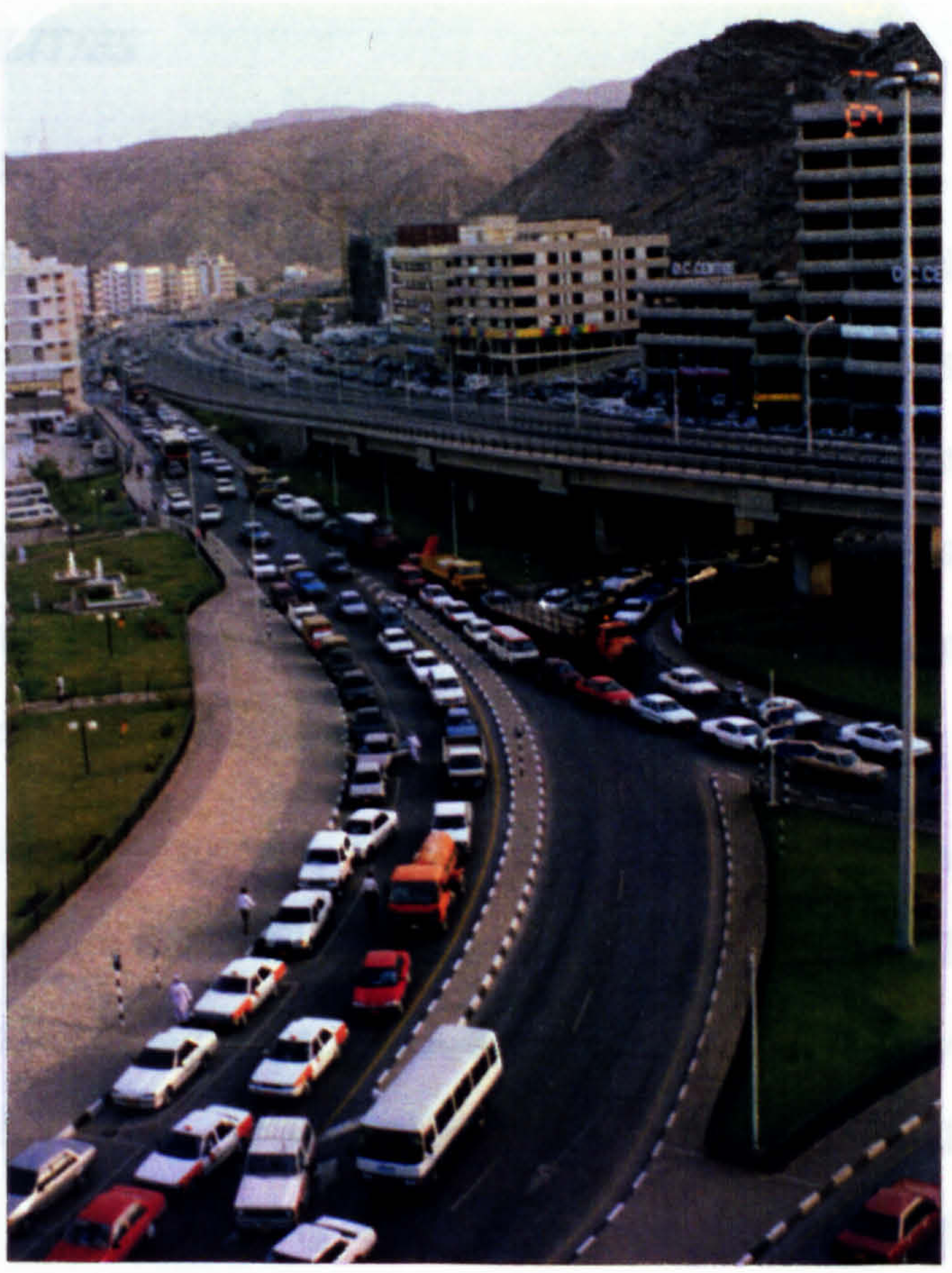


*Plate 4.2*: Traffic flow at Ruwi Roundabout


*Plate 4.3*: Advertisement Boards at Ruwi Roundabout

### 4.5.4 - *POOR PEDESTRIAN FACILITIES*

In the present system, very little consideration is given to pedestrians and cyclists. The frequency of cyclists is very low, pedestrians often cross the path of high-speed traffic without any protection or safeguards whatsoever. This constitutes a serious traffic safety problem. The problem is the danger to pedestrians who cross the three-lane dual carriageway of Sultan Qaboos highway. The need to cross arises from taxis or buses setting down passengers on the opposite side to their destinations, or because the road separates one land use activity from another.

Pedestrian flows across the road are so dispersed, and the footbridge provided in Jibroo and the subway in Al-Khuwair are not sufficient and only handle a very small proportion of pedestrians. Footbridges or subways would be more effective if they were provided widely and their location relates closely to the origins and destinations of pedestrians. It is at the planning stage that these problems of severance can be avoided or at least minimised, by ensuring that land use activities that generate pedestrian movements are located on one side of the road. The Assistant Chief Constable of Sussex, (1988) wrote the following about pedestrians crossing Qaboos road:-

> It appeared to the writer that the many pedestrians who cross the main carriageway of Sultan Qaboos Street, especially along the stretch where several buildings occupied by Government departments are situated, were in great danger of becoming accident victims[31].

Details of this traffic problem are described in Chapter 6, in which the impacts of the motor car in terms of traffic accidents, pollution and measures for pedestrian safety are also discussed.

### 4.5.5 - *INSUFFICIENT LOCAL ACCESS*

One of the existing problems for all forms of transport is the inadequate provision of access to some of the new areas of development. This problem is not so marked in the older areas, such as Muttrah and Muscat, where a variety of activities are packed sufficiently close together, so that vehicular trips are less necessary. It is with the dispersed location of new development areas throughout the Muscat Area that the problems became significant, where vehicle use is necessary for almost all trips (see section 3.4.4). The problems caused are:

a - Hindrance and danger to other traffic when vehicles leave or join main roads at almost any point, restricting the capacity of the road.

b - Vehicles have to travel extra distances. There are inadequate access roads at local level areas or service roads parallel to Qaboos Road, (e.g. the section from Ghabra Roundabout to Adhuba Roundabout).

c - Pedestrians are presented with long walks between the buildings and taxi/bus stops. There is the danger of having to cross busy roads.

With a far faster growth in vehicle numbers than anticipated these problems now require consideration.

### 4.5.6 - *INSUFFICIENT ROADS IN THE MAJOR COMMERCIAL AREAS*

The concentration of commercial activities in the high density built-up areas of Ruwi and Muttrah and along the highways cause traffic congestion. This is mainly because no allowance has been made for sufficient road and parking space for the traffic attracted to these areas. The prime examples are old Muttrah Road and Ruwi High Street. Apart from the inconvenience of traffic congestion in the vicinity of the buildings, delays soon affect other traffic on adjacent sections of the road system. Dar Al-Handasah consultant (1985/87) commented on this in the Capital Area Transport Study: -

> The worst traffic congestion in the Muscat Area occurs along Ruwi High Street and Muttrah High Street for long periods. Directional peak-hour traffic flows at those locations exceed 1000 vehicles and, combined with the reduced capacity due to parking, access and pedestrian activities, the result in very low speeds and long delays(26).

### 4.5.7 - *UNBALANCED PATTERN OF URBAN AND ROAD DEVELOPMENT*

The traffic congestion which occurs in parts of the Muscat Area results from the change in the mode of travel from the pre-1970 situation when the development pattern was related to non-motorised transport (820 vehicles registered in 1970 for the whole country[(32)]), to the present widespread use of vehicles, but without a corresponding adaptation in access arrangements or density of land use activities. Traffic generates from new developments in excess of the road capacity and car parking provision (see Chapter 3).

Planning development neglected the importance of arranging urban activities so the need for movement has not been greatly reduced. The location of new development is also becoming more dispersed resulting in an increase in the need to travel long distances within the Muscat Area (see Chapter 3). The following statement from David and Kim (1987), applies to the effect of dispersed low density development on the Muscat Area road network:

> The combination of dispersed low density development, a rapidly increasing standard of living, and the lack of public transit service, resulted in large increases in the use of automobiles and longer trips, resulting in even more congestion[(33)]

The concentration of work places in certain areas (e.g. CBD area, Airport area, part of Al-khuwair and Qurm) also has a very significant effect on traffic congestion, particularly on the roads leading to them during the peak hours, thus necessitating long travel between home and work place. The concentration of commercial activities in Ruwi and Muttrah, therefore, requires many people who live outside these areas to make long trips for shopping and business purposes (see Chapter 3 and 7). Due to the densely built-up areas coupled with the limited number of narrow routes, traffic movement in Ruwi and Muttrah is quite disorganised, where pedestrian movement and on-street parking disturb the flow of the traffic (see plate 4.2). Therefore, the traffic operations on the streets leading to them are characterised by the delay of intersection and the low level of services and are severely congested during the evening peak hours ( *plate: 4.4*).

*Plate 4.4* :Traffic Congestion on Ruwi High Street

### 4.5.8 - *INADEQUATE HIGHWAY CROSS DRAINAGE*

During the rainy season in Muscat, the impact of the topographical conditions, mountains and hills, together with steep catchments which include large areas of impervious rock, cause water to gather very fast and run rapidly through the built-up areas towards the sea. As mentioned earlier in Chapter 2, the rainfall is typically very intense for a short period and often occurs over small localised areas causing flooding[34]. Therefore, the floods cause extensive damage to property and communication systems, and loss of life. Floods that have occurred recently have all caused damage and disruption of public services and some have caused loss of life[35]. According to the Royal Oman Police in the 1992 rain season, 21 persons lost their life as a result of floods in three days of the rainy period[36].

Prior to the development of the coastal strip, flood flows were carried by valleys directly to the sea. Downstream of the mountains, on the flatter coastal plain, the valleys were less distinct and in major floods water would dissipate over a large area towards the sea, (e.g. area between Burg A'Sahwa Roundabout and Ghabra Roundabout and the area between Mawaleh Roundabout and Khod roundabout).

Development of the coastal plain for industrial, commercial and residential use and construction of roads has disturbed the natural flow path. In certain areas, development has taken place in the valleys themselves thus reducing the width available to accommodate flood flows. In Muscat and Muttrah towns, for example, there is no natural water course remaining in them and flood waters are forced to flow along the streets.

Where roads have been built across valleys, there is often insufficient or no provision for storm drainage beneath the road. In many locations, there are low lying areas that have no surface drainage system and thus collect water after a storm. This turns these areas into temporary lakes, with houses surrounded by water and their roads overflowing. Generally, during the rainy season, pockets of water are commonly seen on the Muscat Area roads, causing traffic congestion and accidents.

From the foregoing, flooding has a great influence on the Muscat Area, especially on roads which are considered the most vital, and an arterial link between the city areas. As the Muscat Area lies in a series of valleys, bowls and a narrow coastal plain, amid complex topographical features, the main roads follow the natural course of valleys. Therefore, many Irish Crossings (fords) are located on the road network. It is worth speculating on some features of the vital roads (Sultan Qaboos Road and Al-Hajar Road), before discussing the effect of the flood on the road system and it's related traffic problems:-

*Sultan Qaboos Road:* The Road runs parallel to the coast in an east-west direction reaching a maximum of 2 km inland from the sea, linking together the Muscat Area and formatting the start of the national road network to Al-Batinah and the Interior. The road from Muscat to Seeb was constructed in the early 1970s as a single carriageway. It was dualised in the late 1970s by adding a carriageway and central reservation on the coast side of the existing single carriageway, and by extending the existing culverts and Irish Crossing. In 1984/85, the carriageway was widened from Wattayah to Burj A'Sahwa and resurfaced. Red interlocking paving was added to the existing central reservations. Service roads were constructed along some lengths. Because the road alignment is situated across several flow paths, the flow from the hills and further south in the Al Hajar mountains pass through it towards the sea. On some sections of the road located in areas, (e.g. the area between Mawaleh and Al-Khod roundabouts), it is often difficult to distinguish flow paths.

*Al-Hajar Road:* This is the only link between Al-Amarat municipality and the rest of the Muscat Area. It winds up the impressive steep sided Wadi Adai gorge. This gorge cuts through mountain Qirmadhil and forms the principal outlet for surface water run-off from Al-Hajar Bowl. The Bowl and the surrounding mountain contribute a 320 sq. km catchment area to the gorge[37]. The road rises 40 metres in elevation over a length of about 8 km, and it follows the path of the valley, crossing from side to side by means of Irish Crossings. In some places the road is elevated on an embankment. At the top of the gorge, the area opens out into Al-Hajar Bowl and the single carriageway road continues to Quriyat. The construction of the present single 7.5 m wide carriageway road dates from the early 1970s, and is already heavily trafficked as far as Al-Amarat municipality.

The problem caused by rain water flooding the roads where there are Irish Crossings could stop the traffic completely as water can reach more than 40 cm in depth. In these cases, several vehicle drivers attempted to negotiate the water too fast which resulted in engines stalling and the road being blocked. Boulders and other debris deposited on the road by the rush of flowing water can cause severe damage to vehicles and when the flood is drastic, vehicles can be swept away, resulting sometimes in death. As a result, vehicles would queue in front of the crossing for long periods of time depending on the quantity and duration of the flood ( in complete isolation, day or night), since there are many Irish Crossings in each road (*see plate 4.5*).

Another aspects of the problem is that a large number of drivers refuse to queue in an orderly fashion and overtake stationary vehicles on the approach to the water crossing. The outcome of this is that when the water is reduced and it is considered to be safe for vehicles to negotiate the water, the traffic congestion becomes so great and under the effect of the flood debris obstruction it requires a long period of time and effort before reasonable traffic flows could be resumed (*see plate 4.6*).

*Plate 4.5*: Irish Crossing on Qaboos Highway

*Plate 4.6* : Traffic Congestion in front Irish Crossings

## 4.6 - "CATS" FORECAST TRAVEL AND ROAD NETWORK(26)

As mentioned earlier, no major increase in highway capacity has taken place since 1985. Therefore, it is worth considering the impact of the Capital Area Transport Study forecast travel demand on specific links of the existing road network, to identify how far it can cope with the traffic movements. The Consultants' forecast travel demand was examined for links along strategic corridors and in problematic areas, on the basis of the Capital Area Structure Plan (1982) population and land use distribution policy.

Dar Al-Handasah consultants indicated in 1986 that the major east-west corridor at Al-Nahda Street has an existing spare capacity of 30 per cent, and it will reach full capacity between 1990 and 1995. The alternative link at Qurum Heights Street (Qurum-Darsait Expressway) has an existing spare capacity of 50 per cent. This will reach full capacity between 1995 and 2000. Taking the two links together the existing spare capacity in the east-west corridor was 40 per cent in 1986; the combined capacity will be reached around 1995. Therefore, there will be a need for additional capacity for the east-west traffic movements some time before 1995 (*Table 4.2 , Station 4 &5*).

Sultan Qaboos Road at Qurum, west of the merge with Qurum Heights Street, had an existing spare capacity of 50 per cent. This section will reach full capacity shortly after 1995. Qaboos City Street south of Qurum Roundabout was very near full capacity at 1986 with only 15 per cent spare capacity. Therefore, it was anticipated to reach its full capacity before 1990. Combining the above two routes, there was a spare of 45 per cent with full capacity to be reached by the end of the century.

Sultan Qaboos Road, east of Ghabra Roundabout, had an existing spare capacity of 60 per cent with full capacity to be reached in the year 2000. The parallel route from Boashar Roundabout to Al-Khuwair is heavily used. It was anticipated to reach its full capacity by 1990. Combining the two links, full capacity will be reached around 1995. Therefore, additional capacity will be required by 1995. The Sultan Qaboos Road, east of the Airport Roundabout (*Table 4.2, Station 3*), had an existing spare capacity of 65 per cent. It will reach its full capacity around the year 2000.

Wadi Adai-Quriyat Road had an existing capacity of 40 per cent on a daily basis, but peak-hour capacity had already been reached. It was expected that additional capacity would need to be provided before 1990.

Muttrah High Street, running east-west, was very close to full capacity, with only 15 per cent spare capacity. Full capacity was expected to be reached before 1990. In the west-east direction, the full capacity had already been exceeded. It was clear that additional capacity was urgently required in this area. The alternative east-west, Al-Mina Street (at Jibroo) had an existing spare capacity of 35 per cent, with full capacity to be reached around 1995.

In the Ruwi Area, Ruwi High Street was running just over full capacity. Al Jaame street had spare capacity of 20 per cent, but was anticipated to reach full capacity by 1990. Ruwi Street was also very close to full capacity in the northbound direction with only 5 per cent spare capacity left. Full capacity was expected to be reached in 1987 or 1988. In the southbound direction there was a spare capacity of 30 per cent and full capacity will be reached by 1995.

In the western part of the Muscat Area, Qaboos Road between Mawaleh and Burg A'Sahwa roundabouts, was expected to reach full capacity in the year 2000. This implies that some form of by-pass or additional capacity will be required by that time. The single carriageway from Seeb Roundabout to Al-Khod will reach full capacity between 1995 and 2000 and therefore it will require dualling, unless other new routes are provided. No serious problems were envisaged in the rest of Seeb municipality, but the consultants recommended that the implementation of planned developments should be dove-tailed with appropriate network enhancements in order to provide good accessibility.

In view of the existing condition, as discussed earlier, it can be said that the consultants' estimates are to some extent evident in the existing road network. This is due to the fact that there was every sign that traffic flow on the network will increase rapidly while transport methods and systems, which have already created the traffic congestion, are likely to persist. In some cases the consultants either underestimate or overestimate the traffic flow in specific links of the network. The former, for example, is the case on the Qaboos Road between Mawaleh and Burg A'Sahwa roundabouts, where severe traffic congestion already exists. The latter is the case on the Qaboos City Street where there is still no sign of any serious traffic congestion one year after the consultants' estimates for full capacity.

As mentioned previously, the consultants estimates of future traffic flow on the existing network were mainly based on the previous Capital Area Structure Plan population and land use distribution. Therefore, these estimates will be highly affected by the recent Muscat Area Structure Plan future land use development. Thus, this necessitates the need for these estimates to be updated in order to be integrated with the new land use policy.

## 4.7 - CONCLUSION

The buoyant national economy has resulted in the rapid development of the Muscat Area as a commercial, industrial and service centre during the last two decades. Before 1970 there were only 10 kilometres of asphalt road and 1,817 km of graded tracks. The remaining tracks, totalling over 7,000 km throughout the country, were neglected. Since 1970 the budget allocations for the transport sector and particularly road constructions have formed a significant part of government development expenditures. Hence, by the end of 1990, a total of 4,995 km asphalt paved roads and 20,811 km graded roads were achieved in Oman.

Transport planning activities in Oman emerged in the seventies as a result of the continuous increase in traffic demand and the inability of the existing facilities to match transport demand growth. The Muscat road network was controlled and directed through planning programmes. However, the rapid urban growth among other factors created the existing deficiencies of the road network. These factors include the lack of planning data, the lack of qualified staff, poor planning techniques and study outcome, and the lack of projects implementation.

Topographical features have influenced the shape of the Muscat Area road network and limited its access to the rest of the country and internationally via Al-Batinah Road to the west, Nizwa Road to the south-west and Al-Hajar Road to the south-east. The urban road network is mostly composed of Sultan Qaboos Highway and its offshoots on either side to major residential areas. The existing deficiency of the Muscat Area road network includes the lack of an alternative route to Qaboos Highway, unrecognisable road hierarchy, inadequate road junctions capacity, poor pedestrians facilities, insufficient local access and roads in the major commercial areas, and inadequate highway cross drainage.

## 4.8 - RECOMMENDATION

### 4.8.1 - *GENERAL*

Rapidly increasing demands for transport in the cities of the developing world and the resulting traffic congestion have led to political pressure to find effective solutions. Attempts to solve urban transport problems by huge investments in subways and complex highways have not always been cost-effective, and have often meant that funding for other important services had to be postponed or curtailed(38).

Traffic management measures can assist in reducing congestion and in enhancing road network capacity by controlling traffic movements(19). The term 'traffic management' is used to describe the process of adjusting or adapting the use of an existing road system to meet specified objectives without resorting to substantial new road construction(27), The objective of traffic management is to ensure the overall best use of the existing transportation facilities [39], in order to achieve some or all of the following:

- a reduction in road accidents;
- environmental improvement;
- improved access for people and goods;
- improved traffic flows on primary and distributor roads.

This best use - which may or may not be the maximum use or that generating maximum benefits - involves the imposition upon the traveller of rules and regulations governing the use of transport facilities. It may also involve new works and improvements of limited scale, capable of early implementation. The use of traffic management techniques in respect of road safety, parking and public transport are discussed in more detail in Chapters 6, 7 and 8 respectively.

Conflicting movements between vehicles and between vehicles and pedestrians intensify traffic congestion. This problem occurs mainly at intersections where vehicles and pedestrians make manoeuvres that delay other traffic and are also a potential cause of accidents. Fairly simple traffic regulations associated with the provision of effective information for road users and minor road works can reduce conflicting movements and help to improve the road network to be more efficient in terms of capacity, safety and accessibility.

The traffic management measures most commonly used include installing traffic control signals at key intersections, re-routing and guiding traffic, the introduction of one-way streets and banning the conflicting turns. Although these changes involve extensive installation of traffic signs and signals and road markings (either to reinforce other physical measures or for regulatory or informatory purposes), the costs are very low in comparison with the costs of constructing additional infrastructure.

Minor road works can achieve additional improvement by altering the existing infrastructure - widening roads to provide turning lanes and extra lanes for through traffic, installing traffic islands to channel traffic more efficiently, and building footbridges, flyovers, and pedestrian tunnels to separate pedestrians and vehicles. The use of footbridges, flyovers, and tunnels is often the best technical solution, but is costly and may sometimes be impractical because of the lack of space. More sophisticated efforts, such as traffic control systems that use vehicle detectors and link traffic signals to computers to optimise traffic flow, may be comparatively costly but still provide very significant returns in the form of much reduced journey times and vehicle operation costs.

The cost of implementing traffic management schemes is comparatively low and would produce substantial benefits in both travel time savings and accident provision. Although several traffic management measures can be effective when applied individually at various locations, higher benefits are obtained from comprehensive schemes involving extensive sections of the road network in conjunction with effective enforcement(19). The following traffic management measures and policy options are of the particular significant to the Muscat Area:-

### 4.8.2 - *IMPROVEMENT OF JUNCTION CONTROLS*

The cure for many congestion problems is seen in the construction of additional lanes on the existing roads. Yet congestion is rarely due to inadequate road width; it is more often due to a lack of intersection capacity. Normally congestion does not occur because existing roads or bridges are too narrow, but because the intersection cannot handle the traffic that these narrow facilities are carrying already. Usually it would be more economical to increase the capacity of bottlenecks than to widen roads in their entire length(40).

#### 4.8.2.1 - SIGNALISATION AND CO-ORDINATION OF JUNCTIONS

A key problem in traffic management, of equal importance to separating vehicle and pedestrians, is separation of intersecting traffic streams. The scope for space-separation of traffic streams by introducing roundabouts or flyovers, particularly in

Muttrah municipality, is limited. As mentioned earlier, only a few, but important junctions, are traffic-light controlled. However in the absence of a recognisable road network hierarchy the priority junctions make bottlenecks and are hazardous, particularly at the cross-roads priority junctions.

Signal-controlled junctions, with the flexibility offered by variations in layout and signal timings (including co-ordination of timings) can also be used to reinforce the hierarchy by favouring one route over another in terms of capacity and vehicular delay. They also provide the opportunity to encourage or prohibit turning movements and to help pedestrians to cross at junctions, as well as to ease the creation of a gap for traffic wishing to join major routes. For these reasons they are a very powerful control measure and are widely used in the urban areas. Therefore, it is necessary to set up more traffic signals in the road junctions, particularly where the urban development is highly compacted as in Greater Muttrah municipality.

Computerised traffic signal control systems have become popular for two reasons. They can make the best use of the existing network capacity and reduce journey times without creating adverse environmental effects. They can also provide the basis for an expanded control system incorporating such features as variable message signs, congestion monitoring, emergency service vehicles priority and other intervention strategies[(27)]. At present, traffic signal control is installed in Ruwi, and is limited to a few routes where the grid-style road system offers itself for computerised co-ordination of traffic signals. The present control system is insufficient, and with the severe traffic congestion it is obvious that some of the exiting junctions generally in Greater Muttrah have to be operated with some form of urban traffic control system.

#### 4.8.2.2 - IMPROVEMENT OF PRIORITY JUNCTIONS

In the Muscat Area highway network, extensive use is made of T junctions and conventional roundabouts, whilst in the rest of the network the use is made of T and cross-road junctions. Roundabouts can perform more satisfactorily than signal-controlled junctions at junctions with many approach arms if they are well designed and the traffic demand is reasonably well balanced between the arms. As discussed earlier, the use of the roundabouts in the east-west corridor where traffic demand is high and unbalanced traffic flow between their arms cause bottlenecks.

At present, the study envisages an efficient utilisation of the existing roundabouts. The investment on the improvement of roundabouts can start with signalising of the intersection combined with provision of prescribed signs and markings. With the increasing numbers of vehicles and vehicle usage, it is inevitable that some of the exiting roundabouts, particularly along the east-west corridor, will have to be modified to increase their capacity. Wider approaches and exits or grade-separated roundabouts will be necessary at the critical junctions. Therefore, it is important to reserve land adjacent to each junction and keep it free from any forms of permanent structures that would be difficult and costly to relocate when the need arises.

On the outer highway network boundaries, extensive use is made of T and cross-road junctions. For the time being the cross-road junctions are causing severe traffic congestion and accidents. In the UK, where perhaps the most significant mechanism in junction control has been applied, so-called small or mini-roundabouts which effectively provide a greater capacity for flow through a junction than traditional designs. Capacity increase of 25 per cent is commonly obtained by conversion to mini roundabouts and at some sites considerably greater improvements have been observed(39). Therefore, where necessary, the existing cross-roads junctions can be upgraded to mini-roundabouts, with the exception of the road junctions in Greater Muttrah. The reason that roundabouts are not generally compatible with urban traffic control systems is that the roundabouts cannot respond to positive control commands, in which urban traffic control system is the preferred solution to improve traffic flow and safety in such a high density built up area.

### 4.8.3 - *PRINCIPAL ROUTE FOR THE MUSCAT AREA*

The existing east-west corridor (Qaboos highway) forms the principal transport route throughout the Muscat Area and due to its location in the middle of the developed areas it will continue to perform this role in the future. No real alternative is apparent either to the south or along the coast (see Chapter 5), and there will always be a need for a major route acting as the spine of the Muscat Area and as the beginning of the national road network to all regions of the Sultanate.

The future of the east-west corridor should be viewed as a high speed route, probably as a dual three-lane carriageway in all the road sections, with some junctions either as grade-separated or signal-controlled junctions. It is therefore essential that development adjacent to the existing route does not in any way conflict with this view. The traffic capacity of this vital arterial route is reduced by permitting too many individual access points in between the main junctions. A policy should be pursued of no direct access on and off the route except at the main junctions; this should apply to the existing development wherever possible. Where service roads run parallel or rear to the corridor some form of barrier or road edge should be placed alongside the service road to discourage traffic joining the dual carriageway in between junctions.

The secondary road network in the areas adjacent to the corridor should be planned to provide alternative routes parallel to the corridor for local traffic and local public transport. This would help to avoid the route having to be used by local traffic and at times when the route is closed for maintenance or accidents these roads could then act as relief roads. Such routes are required through areas adjacent to the corridor in Ghabra, Adheiba, Mawelah, Manuma, Ma'abila and between Wattayah and Wadi Adai Roundabouts on both sides of the corridor.

### 4.8.4 - *ACCESS ARRANGEMENTS*

The need to establish a coherent network of access roads becomes more important for both future and existing areas of urban development, with the enormous increase in the vehicle numbers and uses. It is essential that the local network relates efficiently to the primary and secondary roads. In particular, vehicular access on and off the east-west corridor must be strictly limited to the main junctions so that the traffic capacity and safety standard of this route is retained. Service roads or rear access routes parallel to the corridor should provide adequate access to the existing development. Commercial development should not be permitted along regional or other main roads; where possible/necessary, commercial development on main roads should be provided with a service road. Vehicle access to exiting frontage development should not impede the free flow of traffic on these roads.

The distance between regional or other main roads and future development should be greater than the current practice. Where possible it should be set back at least 100 m from edge of regional roads and 50 m from other main roads, for reasons of safety and environmental improvement and to keep the roads free from any nearby permanent structures if future improvement is required.

### 4.8.5 - *ROAD HIERARCHY IMPROVEMENT*

A well- planned and well-designed hierarchical urban road system should be able to accommodate traffic wishing to enter or leave a town rapidly and safely, or to circulate freely within it. It should also be able to provide for any through traffic not diverted to outer bypasses(41). This can be achieved by the development of a network of high-capacity primary distributor highways which are linked to business, industrial and residential districts by separate district and local distributor roads. These link roads, in turn, are serviced by access street systems which enable vehicles to reach houses, factories, shops, car park, etc.(42).

In the Muscat Area such a hierarchical urban road system does not exist. It is, therefore, important to improve the hierarchical structure of the road network by regulating usage of the roads according to their main functions. The various demands should given priority, taking account of the most appropriate role for the road in question and its relationship with other roads in the area, in conjunction with the definitions of the Supreme Committee for Town Planning, Physical Planning Standards, for road network hierarchy classification(9).

4.8.6 - *ACCESSIBILITY IMPROVEMENT*

The normative view of the relationship of people and their urban environment is that knowledge about normal and desired pattern of human activity can be used as criteria for shaping a responsive urban environment(43). One of the key variables in this normative relationship is accessibility, which it is defined as the opportunity of individual inhabitants to enter a variety of local setting in the course of conducting their daily out-of-home activities(44). Accessibility is a function of three factors: the pattern of land use, distribution of people in relation to the land use, and the transport system. Each of these factors is influenced by the other two and together they form a triangle of forces that must be balanced if the people in a city are to obtain efficiently the many amenities and opportunities it offers(21).

In order to achieve sufficient high accessibility level in the Muscat Area, planning policies should devise ways to manipulate the built environment in such a way as to facilitate preferred patterns of activity and maximise opportunities for all inhabitants. It is necessary, whenever there is a change of land use, that priority be given to minimisation unnecessary vehicle travelling, (e.g. decreasing distances between points of origin and destination). This will be necessary due the high proportion vehicle trips (Chapter 3). The location of future residential areas must be viewed in response to accessibility by both private and public transports to employment and commercial areas associated by providing the necessary means of transport facilities and regulations to achieve this policy.

### 4.8.7 - *INSTITUTIONAL ARRANGEMENTS*

Transport planning is a technical/political process concerned with trade-offs among conflicting values of different groups in society. Transport service decisions are often for allocation of resources to different groups in the society and require political ratification aided by technical information. In the developing countries, the absence of sufficient city transport institutions and co-ordination among the various authorities involved, and insufficient trained manpower resources, contributes to many urban transport problems. They critically handicap efforts at most levels of actions from policy investment decisions to management and construction matters. The World Bank referred to this matter in 1986 as follows:

> It is clear from experience with the urban transport lending programs that *institutional arrangements* can determine the success or failure of a project. Projects in a number of cities have proceeded slowly, and this is often attributed to the lack of co-ordination among the large number of institutions involved in urban transport, as well as shortages of trained staff and funds(19).

There is also widespread evidence in the Third World cities of duplication of responsibilities in urban transport planning and traffic management which has led to general lack of clarity as to who does what. Such circumstances are often aggravated by an absence at national level of a single overall co-ordinating policy unit ready to provide guidelines for urban transport(17). Therefore, before considering any guidelines towards sufficient transport institutions in the Muscat Area, it is essential to recognise that planning is a continuous process and cannot be effective and efficient unless it is carried out by an organisation with the capability and authority to do what is needed and has the power of implementation. Responsibility must cover the whole city and all strategic aspects of land use and transport. The planners must be able to co-ordinate their activities with those of transport operators and agencies. They must be in close touch with the political authorities and administrators, have access to available data and information, and have the means of collecting specific data and monitoring trends. Most important, their work must be based realistically on such powers as do and do not exist to control the development of land use[21].

On the above basis, it is important to set up an organisation within the framework of the Supreme Committee for Town planning to deal with the issues of the transportation system in the Muscat Area or in the whole country. The proposed organisation - containing a professional staff and engineering team specialised in transport planning and the implementation of traffic management scheme - should have the capability and authority to ensure that :-

1 - transport planning and policies stem from a common planning process so that the decisions that are appropriate to each are wholly compatible, which means that the organisation has to overcome the existing complex interlocking transport planning responsibilities by working jointly with the concerned authorities and improving the co-ordination among them.

2 - it is capable of managing traffic movements, calling for regular data collection, monitoring of programmes and predictions, updating and modification of plans, and implementation within the government overall policy and available funds. If necessary, it can seek assistance from qualified and experienced consultants.

3 - efficient control and effective law enforcement are provided for traffic management. Regulation and enforcement are essential components of traffic management. They should be reasonable and enforceable. A reasonable regulation (and its enforcement) is one that is, and is seen to be, in the interest of the general public. This requires that regulations and their purpose are clearly understood and there is consistency in their application.

4 - pre-implementation studies are conducted in order to provide the answer to that and how to achieve the results expected. In addition, such a plan should

be developed within the broader context of traffic management actions that are designed to make the best use of exiting transportation resources.

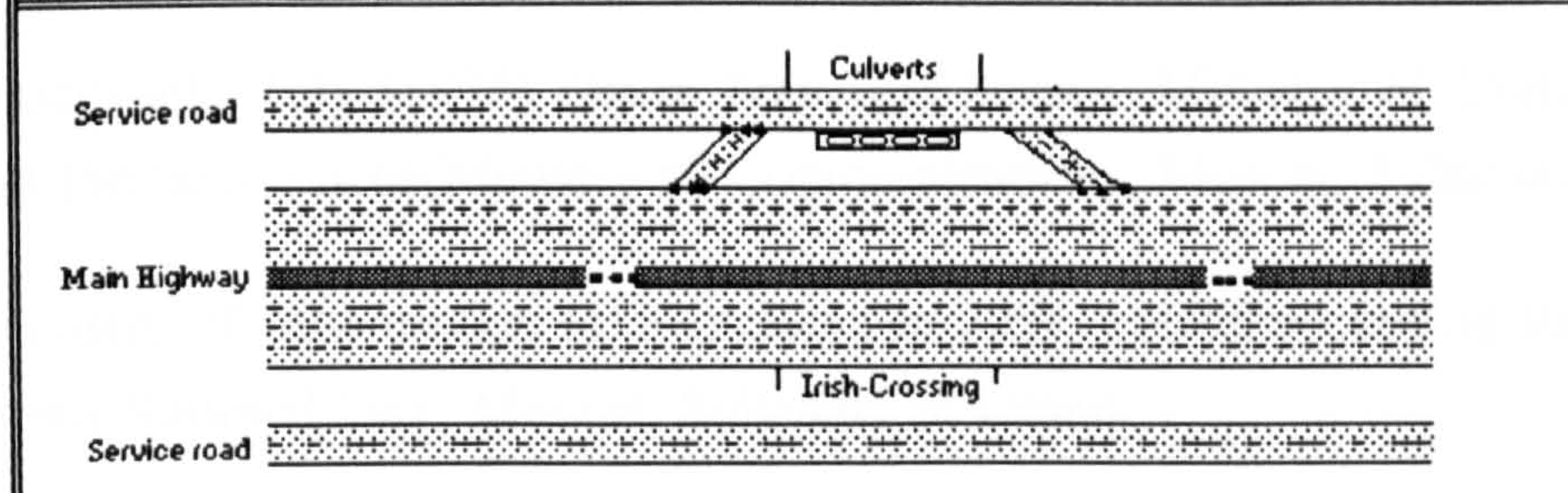
### 4.8.8 - *FLOOD ALLEVIATION IMPROVEMENT*

Flooding has a great effect on the Muscat Area, particularly upon the road network. The city authorities acknowledged this problem and planned to adopt a comprehensive method to control flooding in the Muscat Area road network to enable traffic flow to continue during the rainy season. As a first step towards this aim, in 1987, WS Atkins International was requested by the Muscat Municipality to carry out a combined study for flood alleviation in five different areas within the Muscat Area. The main aim was to make an assessment of the flooding in these areas, and to propose suitable methods of flood alleviation. The study suggested a number of measures to improve the drainage system and alleviate flooding. These included the construction of a number of dams and major construction work to enlarge the cross drainage under the highway network. However, such a comprehensive improvement requires a considerable amount of investment, which may be beyond the spending power of the authorities concerned in this field.

There is no doubt that if the recommended flood alleviation measures are implemented they will reduce or eliminate the impact and the severity of flood flows, and will provide sufficient improvement in the standard of protection offered to the community at large. Therefore, it is important to rearrange these measures into suitable priority scheduling in response to the available funds. Since the Irish Crossings pose considerable danger and delay to traffic especially during the raining and flood season, it is necessary to provide sufficient warning signs in front of the crossings specifying the instructions for safe crossing, as well as communication facilities to ease flood isolation and provide means of emergency aid.

In view of the financial and technical difficulties it is anticipated that the city authorities would have great difficulty in achieving this aim. Therefore, instead of constructing culverts on the main highway it will be easier and cheaper to be constructed on the adjacent parallel service road or bypass, provided that: (a) the culvert openings are sufficient for the expected water flow through them, (b) blockage by debris carried by flood waters with the subsequent rise in flood are avoided, (c) water level upstream should not be too high to damage surrounding areas, and (d) means of traffic diversion together with the relevant instructions are available to facilitate traffic during the water flow, for example, as shown in *figure 4.5* in the case of Qaboos highway.

*Figure 4.5:* Proposed Location for Culvert



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# CHAPTER 5

# FUTURE ROAD NETWORK DEVELOPMENT

## 5.0 - INTRODUCTION

The road system of any city or town is the most important man-made determinant of future growth and development, both in the short and long term. Once defined, it is very difficult to change and normally remains unaltered for as long as the city continues to exist. In this Chapter, the aim is to discuss the proposed major road network currently under consideration in the Muscat Area and to advise on their priorities according to the research outcome. In order to achieve this aim it is necessary to identify and review all previous highway network proposals as inherited solutions.

Before examining these proposals, it is necessary to review the concept of future development strategy and the structure of the urban areas in the Muscat Area because transportation and land-use patterns are compatible, and cannot be separated. Just as land-use policy will have an effect on transport demand, transport supply can be effectively used to encourage land-use development(1).

## 5.1 - DEVELOPMENT STRATEGY

According to the Regional Plan(2), Greater Muttrah is considered a primary centre with highly centralised functions, institutions and businesses of national and international significance. This centre is to be maintained by encouraging development and growth of services and facilities which are of national and international significance and which cannot be suitably located elsewhere in Oman. In addition, Greater Muttrah fulfils centralised functions for the municipalities of Boashar and Al-Amarat.

The Regional Plan indicates that Greater Muttrah will persist in future as the national centre, but due to the over-dimensional growth which took place at Seeb, it is desirable to shift regional central functions there in order to relieve Greater

Muttrah and to increase the efficiency of the necessary public investment at Seeb. It is also indicated that the overall additional population of more than 300,000 people - in the year 2010 - nearly corresponds to the doubling of the actual number of inhabitants. It seems unrealistic that only one " supply centre" for central services will be sufficient in future. Thus, Greater Muttrah and Seeb will have to share this responsibility.

It is anticipated that such a " Twin-City-Approach" to the growth of the Muscat Area will be a *sine qua non* for viable future urban expansion, as it will greatly help to reduce commuting between the eastern and the western parts of Muscat Area, allow for new centres of employment to be established, and generally encourage a more balanced and equitable process of urbanisation in the Area. The Weidleplan consultant also stated that the purpose of this developmental strategy is not to elevate Seeb to the level of primary centre, which would then have to be seen to be in competition with Greater Muttrah. However, both Greater Muttrah and Seeb should be seen to be the secondary centre for their own respective areas. In validation, Greater Muttrah also has the overriding function of a primary centre.

## 5.2 - URBAN AREAS AND URBAN DISTRICTS

In accordance with the hierarchy of urban settlement as set out in the Planning Standards by the Supreme Committee for Town Planning(3), the Consultants elaborated on a subdivision of the overall Muscat Area into smaller, more manageable sub-areas. In respect of urbanised areas, a three-tier hierarchy of urban areas is formulated in the planning standards, these are:-

- ***Local Areas*** : the smallest units of urban hierarchy and typically have around 2,500 residents ( range: 500 - 5,000).
- ***Urban Districts*** : defined at the intermediate level and should serve several local areas with a typical total catchment population of 10,000 ( range: 5,000 - 20,000).
- ***Urban Areas*** : comprise a number of Urban Districts with a typical total catchment population of 50,000 ( range: 30,000 - 50,000).

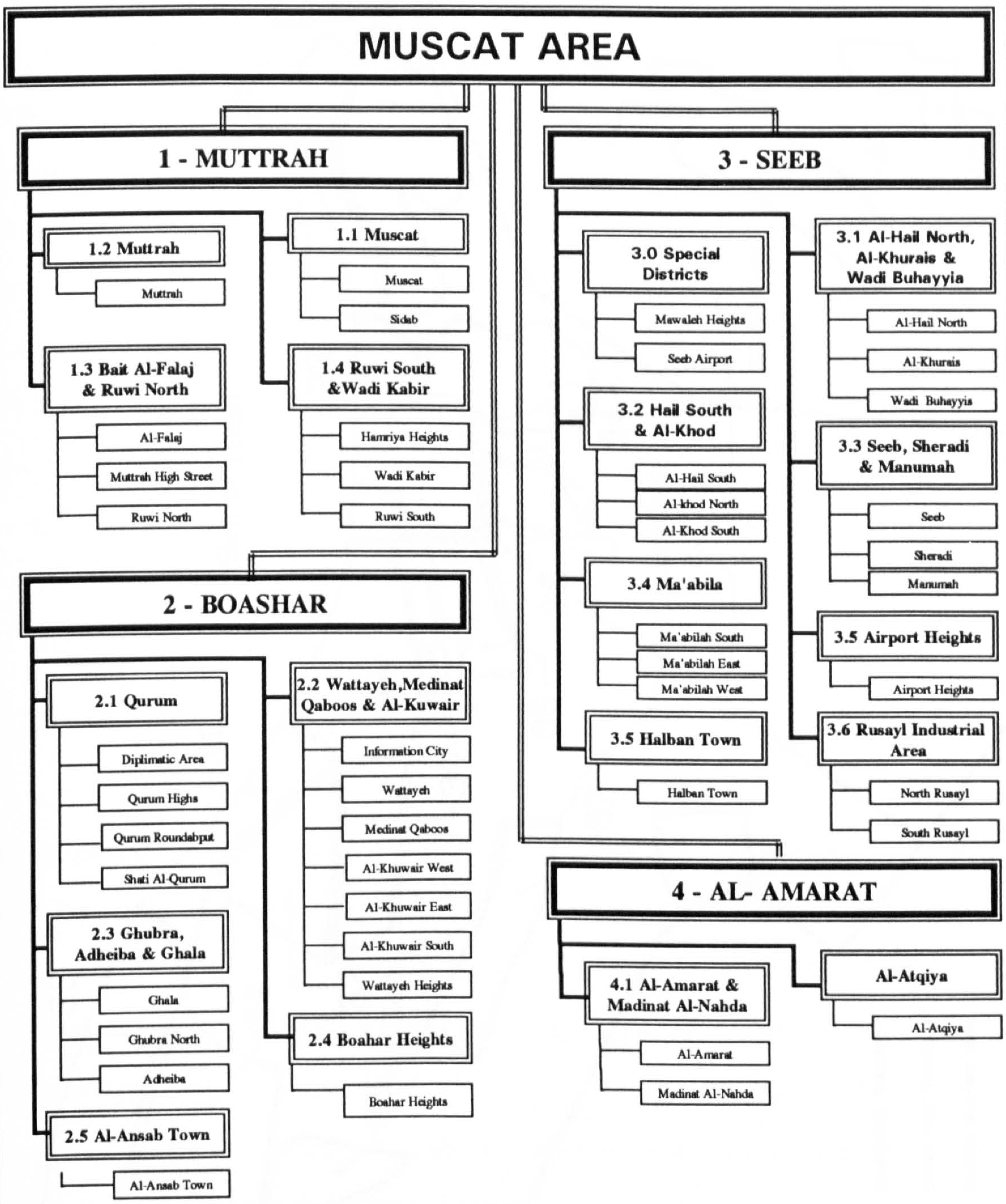
At a higher level, the present subdivision into four municipalities is maintained for the purposes of the Structure Plan formulation: Al-Amarat, Greater Muttrah, Boashar and Seeb. This division is at times somewhat arbitrary, but it is guided by the overriding planning goal of administrative facilitation. Each municipality is, in turn, sub-divided into several Urban Areas with a potential future catchment population of approximately 50,000 residents per area. Thus, the total number of Urban Areas to be provided for in each municipality depends on the finding of the strategies for population distribution and land-use developed in the Regional Plan:

- *Muttrah* : 4 Urban Areas (all areas exist)
- *Boashar* : 5 Urban Areas (of which 3 are added for the period 1990 - 2010)
- *Seeb* : 7 Urban Areas (of which 4 are added for the period 1990 - 2010)
- *Al-Amarat*: 2 Urban Areas (of which 1 is added for the period 1990 - 2010)

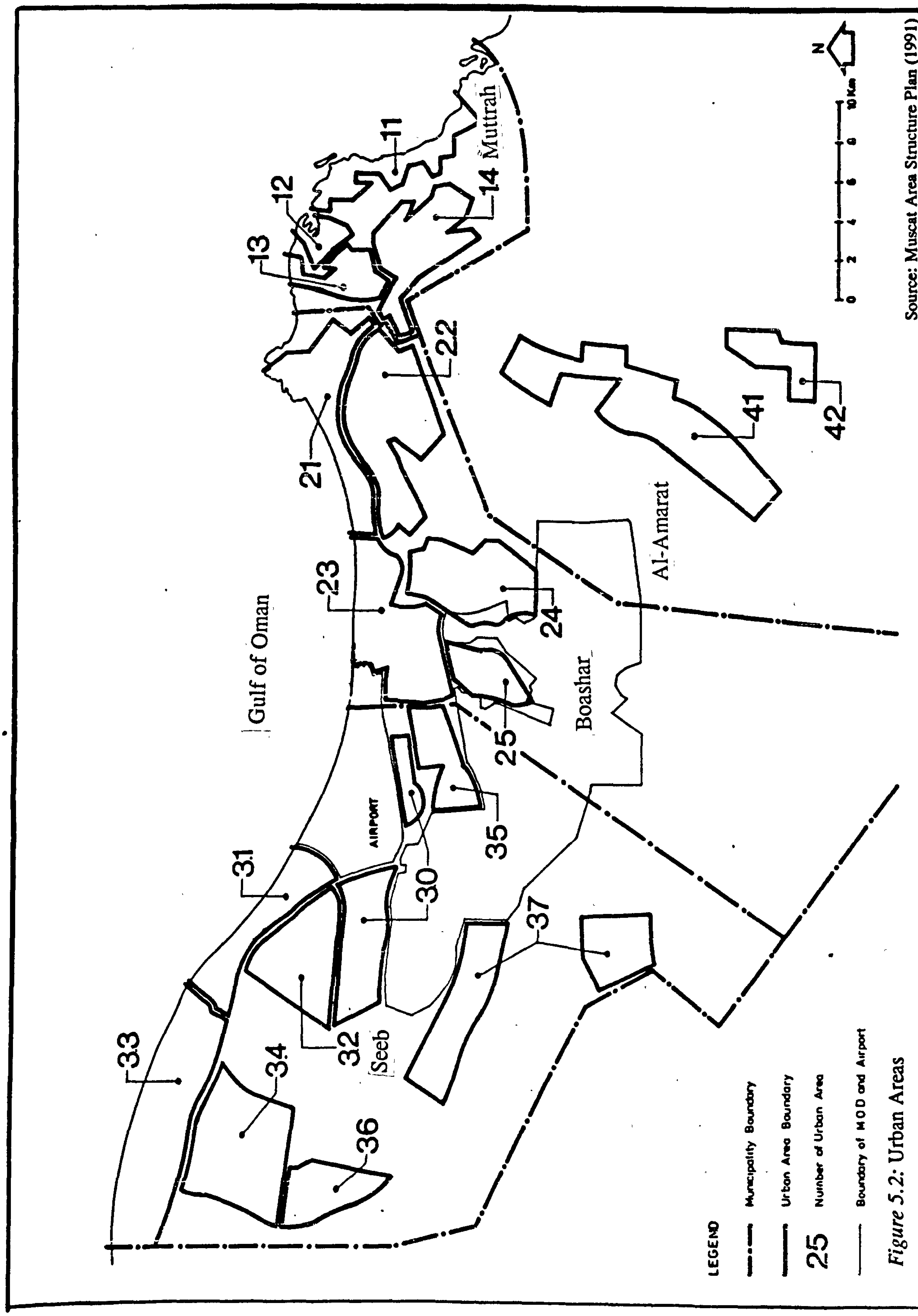
The purpose of subdivision into urban areas is obviously to facilitate the assessment of future requirements for various facilities, etc., as the Planning Standards set out the type and quantity of various services and facilities required per urban area. However, the Consultants indicated that in actually defining the physical delineation of urban areas it was neither possible nor desirable to apply the given catchment-population-range as the only criterion. Rather, numerous other aspects where taken into consideration in defining the urban areas, e.g. coherence of urban units, similarities/dissimilarities in type and intensity of land-use, definition of urban areas as the result of existing/proposed major roads, etc. In addition, some of the urban areas defined have unique characteristics which make it impossible to always fit precisely with the catchment population ranges required, e.g. the CBD -Area in Greater Muttrah which serves not only a limited population but is of regional/ national importance, etc.

The urban areas were in turn sub-divided into smaller urban districts with a projected population of about 15,000 residents by the year 2010. Again, this typical catchment population was taken only as one of several criteria. In the case of the urban districts the element of urban coherence and unitary structure was considered to be of particular importance, i.e. the subdivision was guided by the need to choose areas characterised by a particular overriding planning consideration, so that these districts have district planning themes. The sub-division of the Muscat Area into municipalities and then into urban areas and urban districts is shown in figures 5.1 and 5.2.

*Figure 5.1:* Muscat Area - Urban subdivision




Source: Muscat Area Structure Plan, July 1991




Source: Muscat Area Structure Plan (1991)

*Figure 5.2:* Urban Areas

## 5.3 - FUTURE ROAD NETWORK PROPOSALS

The development in the Muscat Area was very rapid. Prior to 1980, development within the Muscat Area was concentrated in the Greater Muttrah municipality. Outside this municipality, a number of small settlements existed to the west and south. Initially, the area was serviced by a single principal road (Qaboos Road) following the north-west border of the development.

As development rapidly took place within the original crescent area and outside it to the west and south, traffic demand along Qaboos Road built up to an unacceptable level, particularly on the road intersections. Therefore, it was fairly obvious what needed to be done, as since the early 1980s only a two-lane dual carriageway with roundabout intersections was available for any journey within the Muscat Area. Accordingly, the initial location of key arterial roads was set in 1982 in the Capital Area Structure Plan to pass the existing traffic congestion and to service the future development. Previous major road network proposals fall into three categories on the basis of the major road network proposed in each study : -

(i) - Major road network proposed in the 1982 Capital Area Structure Plan[4]

(ii) - Major road network proposed in the 1985 Capital Area Transport Study[5].

(iii) - Major road network proposed in the 1992 Muscat Area Structure Plan[6]

### 5.3.1 - CAPITAL AREA STRUCTURE PLAN (CASP)

This was prepared by Llewelyn-Davies Weeks for the Ministry of Land Affairs and Municipalities (now Ministry of Housing), in 1982. This study provided short, medium and long-term population projection, and land use and housing development required by planning district (5, 10 & 20+ years). The CASP proposed a highway network without any quantitative or qualitative assessment[4]. The transportation planning aim of this study was to correct the principal shortcoming of the existing road system. The proposed network was described in the Capital Area Transport Study as follows: -

> A basic system of leave ways which provide continuous links between all areas of the Capital, regardless of the ultimate size of the city or the various land-uses of its different parts over time[5].

In other words, it was recognised in the Structure Plan that the proposed road network was neither related to any particular time-scale, nor tested to take into account the pattern and size of development within the Muscat Area. In that respect, the proposed CASP network may be considered as the prime network option for the ultimate development of the Muscat Area (roads corridors general setting).

The CASP highway network has undergone several revisions by the Ministry of Housing, Town Planning Department, since the completion of the Structure Plan (1982). The latest state of the CASP network is shown on *figure 5.3.*

As mentioned earlier, the proposed CASP highway network was not assessed against other possible alternative options, but it was developed on the basis of certain " design principals". These are given in the CASP as follows:

(1) - *East West Corridors*: The basic configuration of the Capital Area is linear due to natural constraints. As a result east-west movement over long distances will always be the most important, and vulnerable to interruption. Therefore the Structure Plan sets up independent high speed corridors from the eastern coast to the Al-Batinah plains, incorporating existing routes, and new links where required. To protect these corridors from local traffic, there are two separate continuous systems, one linking the coastal communities from Qurum to Seeb, and the other following the Mountain base from Wadi Adai to Rusail.

(2) - *North-South Connectors*: These main east-west routes are linked by a series of north-south connectors, to allow easy transfer from one route to another, and provide direct passage from inland to coastal communities. As traffic along these north-south routes will always be less critical than along the main corridors, the various communities will take their access from them.

(3) - *A Modern Grid System*: The resulting grid pattern of the major roads provides a simple, sound structure which can be upgraded with extra lanes, overpasses and parallel service roads to serve the long term needs of the expanding city, even when these can only be guessed at. The important point is to reserve the rights-of-way now. The timing of implementation should be determined by the rate at which needs arise and funds are available, which means careful monitoring of priorities.

In addition to the above principal, dimensional standards for existing and planned rights-of-way were set, related to the Ministry of Communications highway standards. Although it was claimed that the proposed rights-of-way were assigned to all major routes, no clear road hierarchy was established in the CASP network.

Certain highway proposals of the CASP have already been implemented (Qurum-Darsait Expressway, Seeb-Hail coastal road, Qantab Road) while others reached the preliminary or final design stage before 1985, but have not been implemented ( Muttrah roads, Ruwi/Wadi kabir Roads, Muttrah-Quriyat Road, Rusail underpasses & associated roads). However, some of the CASP highway proposals, have been revised by other studies( Seeb-Hail-Mabila-Khod Roads, Boashar to Al- Amarat link), and deferred or prejudiced by other developments. A characteristic example is the "Southern Corridor" , which was of central importance to the Structure Plan. The 1984/85 provision of additional capacity along the existing Qaboos Road, in terms of flyovers, extra lanes and service roads, deferred the need at that time for a second east-west arterial road. In the other case, land use development made the construction of the proposed links almost impossible (e.g. the link from Burg Street Roundabout to Sultan Qaboos Road and to Southern Corridor cannot be constructed without encroaching on the land surrounding the Ministry of Housing building). Despite the above limitations of the CASP highway network, its highway proposals form the basis of most current road network proposals.


*Figure 5.3:* Network proposals of the Capital Area Structure Plan (1982)

### 5.3.2 - CAPITAL AREA TRANSPORT STUDY (CATS)

This study was carried out by Dar Al-Handasah Consultants in 1985/87 for the Directorate General of Technical Affairs of the Muscat Municipality. As stated earlier, the objective of this study was to build a strategic traffic model, which could be used to test road network proposals over short, medium and long term planning ( approximately 5, 10 and 20+ years respectively), to establish an efficient road and traffic data collection and processing system.

The purpose of developing the traffic model was to test, assess and evaluate the proposed road network development strategies currently under consideration, and to advise on the phasing of construction of new links and interchanges and the upgrading of the existing roads. This was apart from the main aim which was to enable the Muscat Municipality to apply the developed traffic model in future for the same purposes mentioned above.

The Capital Area Structure Plan (CASP) highway network proposals were recognised by Dar Al-Handasah Consultants as the only form of package of projects available which was fairly consistent with the long term strategic land use development plan for the Muscat Area. In that respect the CASP highway network was considered worth testing for the long term, as a package of projects in conjunction with the equivalent planning scenario based on the Structure Plan. On the basis of the CASP the Consultants also represented all relevant previous proposed highway projects. The key features of each project are described in this section, and also summarised in *table 5.1*, including the location, status reached, the estimated cost, a general description of the work involved and functional characteristics. Their locations, in relation to the existing network, are illustrated in *figure 5.4*.

### 5.3.2.1- SHORT TERM ROAD PROJECTS (up to 1990)

(1) - *Link Between Hamriya Roundabout and Wadi Kabir Roundabout (Road P1)*

This proposal consists of a 2.7 km dual carriageway involving upgrading the existing road from Hamriya Roundabout to the bottom of Ruwi High Street and a new link from the latter point to Wadi Kabir Roundabout. A grade-separated roundabout (Walja) and dualling of the lower section of Ruwi High Street (from the new Walja Roundabout to Honda Road) are also part of the proposals. The dual carriageway will require the demolition of existing commercial strip development alongside the existing main road and also of highly packed housing areas.

Eastward of the new Walja Roundabout the proposed road eclipses the ridge of the mountains on the south side and prior to approaching Wadi Kabir some major rock cut will be necessary. For the crossing of Wadi Kabir a culvert crossing or a bridge may be proposed. The final 300 m of the proposal is through a reserved corridor and no major demolition work is necessary.

(2) - *Wadi Adai (Muttrah-Quriyat) Road Dualling to Al-Amarat*

At present, Wadi Adai Road is the only link between Al-Amarat municipality /Quriyat and the rest of the Muscat Area. This road initially follows Wadi Adai and meanders through mountainous regions. The resulting tight curves make overtaking very difficult and very often long queues are formed behind slower commercial vehicles. Also, flooding often occurs due to the Wadi overflowing.

The current proposal being considered is the dualling of approximately 18 km of the existing road commencing at Wadi Adai Roundabout and ending at Madinat Al-Nahda. Six major intersections, the majority of which in the form of rotaries, are proposed to link existing and future communities together with six major bridge structures for crossing wadis (water paths). The bridge spans range between 100 metres and 300 metres. Some major rock cutting is also involved as the proposed road deviates from the existing road in certain locations. A approximately 40 to 50 metres of rock will have to be cut around km 5 of the project. The project also proposes surface water drainage and lighting installation.

In view of the existing very high peak hours flow, regular traffic congestion occurs between Al-Amarat and Wadi Adai roundabout. Complete dualling of the road has been proposed and is currently being implemented on the easier sections of the road. However, dualling of the Wadi Adai gorge section will be very costly, and in the absence of an alternative route, diverting the existing traffic will create significant constraints on this section. The traffic congestion and accidents along this section of the road with the existing condition is expected to worsen, unless immediate improvement programmes are performed at least at the critical locations.

(3) - *Improvement of Wattayah Roundabout to Wadi Adai Roundabout*

The existing link between Wattayah Roundabout and Wadi Adai Roundabout which forms part of the main east-west corridor (Qaboos Road) is currently a dual two-lane carriageway. The highest concentration of traffic in the Muscat Area highway network occurs along this section. During peak hours this effectively forms a " bottleneck" as the adjacent links to the roundabouts are dual three-lane carriageway. This link is just over 2 km long and there are two separate proposals and detailed design studies carried out for this section. : -

(i) - The addition of third lane to both sides with provision for street lighting and other facilities.

(ii) - The addition of two-way, two-lane service road on both sides. The service roads commence at the Wattayah Roundabout and extend parallel to the existing road until the Wadi Adai Round about.

(4) - *A New Link from Qurum Roundabout to Nizwa Road*

As an alternative to the above dualling of existing Nizwa Road, studies and detailed designs have been carried out to identify alternative corridors and roads to link the

Muscat Area and inland of the country, considering traffic growth and development of the area generally. Within the scope of the project, alternative corridors have been studied based on planning constraints and reserved transport corridors of the new highway.

The recommended highway starts at Qurum Roundabout and follows the existing road to Qaboos City for approximately 4 km and crosses an oil pipeline approximately 2 km from Al-khuwair Roundabout. After 4 km it takes a course in the south-westerly direction crossing roads to Boashar, Ghala, and then past the Cement Works to meet the existing road to Nizwa. The existing Cement Works road from the Nizwa Road to the work site forms, for the most part, one of the carriageways of the new highway. The work involves new dual two-lane carriageway of approximately 30 km in length together with the upgrading of approximately 7 km of the existing Cement Works Road. Five interchanges and three flyovers are proposed at intersections with roads to Boashar, Ghala, the Cement Works and Nizwa Road. Major earthworks are necessary for the section across Jabels (mountains).

The work also includes demolition of the existing highway, culverts, Irish Crossings, prestressed and reinforced concrete works for structures such as wadi bridges, underpasses, flyovers, retaining walls etc. The proposed alignment goes through mountainous terrain and follows difficult passages, especially between km 20 and km 24 where several wadi crossings are necessary. The upgrading of the existing Cement Works Road is to be achieved by generally overlaying the existing road surface. The design is to an expressway standard with wide central median and shoulder along the travel-ways. Lighting is also provided within the scope of the project.

(5) - *New Link between Qurum Roundabout and Wadi Adai Roundabout*

The project involves the design and construction of approximately a 5 km long single carriageway road linking Qurum Roundabout with Wadi Adai Roundabout at a design speed of 60 kph. The alignment of this proposed link commences 300 metres to the south of Qurum Roundabout and takes an easterly route towards Wadi Adai. It then follows the Wadi (valley) for the majority of its length and finally intersects with the existing Wadi Adi (Muttrah-Quriyat) Road at some 200 metres south of Wadi Adai Roundabout.

Intersections are provided along this road south of Qurum Roundabout with provision for it to tie the proposed dual carriageway (Madinat Qaboos Street) and the interchange planned for this area. Apart from the intersection at the tie-in point to Wadi Adai Road, two additional intersections are also provided at crossings with existing minor roads. The carriageway will have shoulders on either side. A major Irish crossing is provided at the wadi with protection works along the wadi in areas of embankment.

(6) - *Muttrah Road Upgrading and new links to Mina Roundabout and Cornish*

This project encompasses a comprehensive urban road proposal in the Muttrah District. The final design has been carried out for the improvement of Muttrah High Street, and roads linking Cornish Road and Mina Roundabout. The project can be divided into the following sections:-

(i) - Dualling of Muttrah High Street between Muttrah Flyover on P4 road and Muttrah Hotel.

(ii) - One way gyrator road proposal between Muttrah Hotel and Juma Furnishing Building by constructing a new link parallel to Muttrah High Street; running behind the hotel and joining the existing road after Juma Furnishing Building.

(iii) - One way gyrator road proposal, with two lanes in each direction down to the Hospital with utilisation of existing one-way corridors.

(iv) - Dual carriageway construction between the Hospital and Sanyo Corner.

(v) - Dual carriageway construction for the legs of Muttrah Road linking Jibroo Roundabout and Riyam Roundabout.

(vi) - Construction of a flyover at the intersection with the Cornish.

The proposal involves a comprehensive allocation for commercial and residential parking. Major demolition works will be necessary along the length of the new link and wherever the road is widened to accommodate travel ways, sidewalks, parking etc. The total length of the new road is approximately 3.6 km and will involve major surface water drainage works, utilities, relocation and beautification works.

(7) - *Mina Qaboos Connector to Jibroo/Qurum Hights Street and/or Upgrading of Al-Mina Street.*

Preliminary studies have been carried out on the existing road system to improve the circulation at Mina Roundabout and to cater for additional traffic likely to be generated from the Jibroo area and Mina Qaboos (Qaboos port). The proposals include:

(i) - Redesigning of Mina Roundabout and upgrading Mina Street. This involves widening to three lanes of the existing stretch of Mina Street from Mina Roundabout to Qurum Hights Street, together with the construction of a grade separated interchange in the form of a flyover ( in the east-west direction) and connecting slip ramps at the Mina Roundabout.

(ii) - An exclusive road for the port traffic running along the foothills, north of Jibroo development area lying north of Mina Street. The main entry/exit will be taken up from the existing roundabout inside the port. A portion of this road, in the eastern section has been elevated to provide a grade-separated crossing with the low-level north-south road, which connects Royal Oman Police complex and Sotaffi village with the Jibroo Area. The port road extends westwards beyond the flour mill before one of its carriageways swings southwards to cross Mina Street in order to receive traffic from Darsait and Qurum Hights Street. A major structure will be required at that location. The westbound carriageway will be connected to Qurum Hights Street and Mina Street with a directional ramp.

(8) - *Underpasses at Burg A'Sahwa Roundabout*

The project comprises the construction of underpasses on either side of Burg A'Sahwa roundabout in order to facilitate the uninterrupted flow of traffic between Sultan Qaboos Road and Nizwa Road. The underpasses are situated away from the central island of the roundabout, as it is the site of the national monument. An alternative proposal, for example flyovers, would have obstructed the view from the surrounding plains.

The underpasses will have two-lanes in each direction with provision at appropriate slip roads from the existing dual carriageway. Also, in addition the first section of the Nizwa Road will be duelled for approximately 5 km. Four bridge structures for over passing north and south legs of the intersection will be required together with a comprehensive drainage system via pumping houses and beautification befitting the location.

(9) - *Dualling of Nizwa Road within the Muscat Area Boundary*

The existing link from Muscat Area to the Nizwa and the surrounding region is via Burg A' Sahwa roundabout on Sultan Qaboos Road and a two-lane single carriageway which runs in a westerly direction for approximately 3 km and then turns to a more southerly direction, eclipsing the Rusail Industrial Area on the eastern side. The road initially crosses a flat coastal plain before approaching an area of low hills at Rusail. These hills have shallow slopes facing the coast and steeper facing inland. The road then passes through the Wadi Rusail Valley which is bordered by rocky hills. The road passes on the eastern side the village of Muayara, near the Muscat Area boundary. At this point there is also an existing junction linking a road to the Cement Works sited some 9 km east of this point.

The proposal involves dualling of the existing road with two-lanes in each direction. It commences from a connection point at Burg A'Sahwa roundabout with the provision of suitable links to the proposed underpasses at the roundabout (Project No. 12). The proposal involves the use of the existing road as one side of the carriageways. The alignment of the proposed section carriageway follows wherever possible that of the existing Rusail to Nizwa Road. The second carriageway is to be to the right of the existing road in order to avoid the communication cable which runs along the left side of the existing road. In certain restricted areas it necessary to realign both carriageways completely.

Service roads are proposed between approximately km 7 and km 9 to act as collector roads of adjacent development areas. Five grade-separated interchanges of diamond and trumpet types and three grade-separated interchanges are proposed. The principal interchanges are to give access to the Ministry of Defence Establishment adjacent to the road, Rusail Industrial Estate and the existing junction road linking the Cement Works. Up to the Muscat Area boundary the road traverses simple terrain with the exception of the final 2 km where some rock cuts will be required.

Apart from the structure for the interchanges, a major wadi bridge of approximately 150 m span will be required around km 11 for flood of 100 year return period. At other locations where the road traverses wadi beds, culverts are proposed with the capacity for flood of 50 years return period.

(10) - *Wadi Kabir Service Road*

The existing dual carriageway from Ruwi to Bustan runs along the side of Wadi Kabir in a southerly direction. The region of Wadi Kabir is experiencing rapid growth in urbanisation with developments spreading along the sides of this road.

There is already an existing service road on the eastern side serving semi-residential /commercial areas. A similar service road is proposed to run on the western side for a length of approximately 7 km. The service road will run parallel and as close as possible to the main highway in order to allow future development along it, within the restricted width against a parallel bridge. During the construction of the main highway the ground has been already graded according to the line and level of the service road. Also, along this length two underpass bridge structures have been built, at midway point and at the end to connect the service road on eastern side. The junction at the former underpass is fully asphalted and lit. The work for the service road will also include further lighting and beautification and slope protection work along wadi beds.

It is worth mentioning that only part of Wadi Adi Road (project no. 1) has been implemented in this Phase. This is due to the government attention to other priorities after the downturn in oil prices in 1985 ( see Chapter 1 and section 5.4.2 of this Chapter).

### 5.3.2.2 - MEDIUM TERM ROAD PROJECTS (1991-1995)

(11) - *Seeb Municipality Road Network*

Preliminary studies have been carried out for the road network in Seeb municipality in relation to the planned urban development. The main features of the network are as follows : -

(i) - By-pass to Seeb which can also serve the expansion areas south of Qaboos Road. The route is an extension of the southern corridor as defined in the Structure Plan (CASP), and runs between Beit Al-Baraka Roundabout and Burg A' Sahwa Roundabout. The road will be a dual three-lane carriageway with viaducts to be constructed over all the roundabouts at a later stage.

(ii) - An intermediate east-west dual carriageway links Mawelah and Ma'abila South.

(iii) - Two north-south dual carriageways link Qaboos Road and the proposed Seeb by-pass.

(iv) - Dualling of existing Al-Khod Road from Al-Khod Roundabout on Qaboos Road to Sultan Qaboos University.

( v) - A link Between Mawelah Roundabout and Al-Khod Road

(vi) - Upgrading of the existing roads in Seeb town, Shradi and Ma'abila North.

Overall the proposal involves nearly 65 km of new road network and 5 grade separated interchanges. The design speeds for geometric limitations range between 100 kph and 30 kph. The proposal includes comprehensive storm water drainage system, land drainage system via culverts, street lighting, utility corridors width ranging between 6.5 metres and 10 metres. Pedestrian facilities and landscaping have been suitably designed to meet the needs of the development as a whole.

(12) - *Boashar to Al-Amarat new link*

This is an alternative link to Al-Hajar Bowl and would greatly improve the integration of Al-Amarat residential developments with the overall urban fabric of larger Muscat. Whereas presently these areas can only be reached through the congestion and dangerous road of Wadi Adai gorge, an additional link to Al-Khuwair Roundabout would place Seh Al-Dhabi as a major cross-roads and thus greatly increase accessibility.

Since the road has to cut through a mountainous region, two main options are considered:

(i) - 14.5 kilometres long surface route

(ii) - Combined tunnel and surface route of 11.4 kilometres

These basic options are considered with further options and alternative cross-sections. The principal options and cross-sections are:-

Surface option: - Two-lane plus a single climbing lane on Jable(mountain) section
- Four-lane plus a single climbing lane on Jable section as divided highway (i.e. two-lane dual carriageway).

Tunnel option: - Four-lane divided highway with twin tunnel (d. carriageway).

The surface option would include a 6 km length traversing very steep terrain over the Jable while the surface/tunnel route would includes a 3 km length of tunnel. The proposed route of the project crosses three distinct topographic zones:-

i) - Boashar Valley, a generally level, gravel bottom valley scattered with hills

ii) - A steep ridge rising to a level of 500 to 600 metres above Boashar valley. The road crosses the ridge where it is approximately 3 km long.

iii) - Al-Hajar Bowl; an extensive flat depression with wadi beds.

As a result of the types of terrain crossed by the road, gradients of 10 per cent are adopted. The horizontal alignment is very winding where it crosses deep gorges. Often curve radii ranging from between 100 m and 150 m are utilised. For the tunnel section the horizontal alignment is straight with maximum gradient of 3 per cent. Overall the project proposes the use of reinforced retaining walls, steel or concrete beam bridges.

(13) - *Darsait Interchange Phase III and Jibroo Service Road*

Darsait interchange links expressways to Qurum and Cornish with dual carriageway roads to Ruwi. Intermingling with the local traffic causes severe traffic congestion. As part of Phase three, proposals are made for a faster exit/penetration network of slip roads around the Darsait Flyover. The construction of Phase three of Darsait-Qurum dual carriageway will have provision for different movements by providing direct and unobstructed exit and penetration for the slower and intermittent local traffic and faster traffic of the freeway. The construction of a service road on the southern side of Mina Street between Beit Al-Falaj roundabout and Mina roundabout will act as a collector road for the development along this side.

The complex proposal of 2 km directional and semi-directional loop will involve substantial structural works, in addition to the construction of five bridges. The structural work will be in the form of concrete slope protection, culverts and retaining walls. Major rock cuts will also be necessary for the service road. Some demolition of properties will also be necessary. Overall the construction of the loops and the service road will be extremely complicated in relation to the maintenance of the smooth flow of traffic and the minimising of disturbance to the local community.

(14) - *Central Business District South Storm Channel Crossings*

The CBD South lies between the north and the south boundaries of Al-Jaame Street and Honda Street respectively and east-west boundaries of Road P4 and Wadi Kabir respectively. The future development of this area will have limited access via the roads named above. Preliminary design study proposes additional crossings across Wadi Kabir to improve the link to this area. Bridge structure, to withstand 100 years rate of rainfall intensity as forms of crossing for the broad and shallow wadi would be expensive. The road crossings would therefore be in the form of culverts withstanding at least 50 years rate of return rainfall intensity.

(15) - *Dualling of Muscat-Bustan Road*

The project involves the dualling of the present single carriageway road between Muscat town and Al-Bustan, over a distance of approximately 5.5 km. The project commences at the Ministry of Commerce and Industry old Building in Muscat and terminates at the existing roundabout junction near Al-Bustan Palace Hotel.

Certain matters of particular importance related to the dualling of the existing road are: -

- Stability of rock cuts
- Realignment of the existing road over the middle portion
- Property acquisition.

Extensive property demolition, mostly on the west side will be required for the early section between Muscat and Sidab. Over the middle portion the road passes over a bay to avoid further property demolition on the west side. For safety reasons, some rock stabilisation will be required over this length as part of the main earthworks operations. The final section of the road is physically difficult; where the existing alignment is substandard and unsatisfactory. Additional costs will be incurred for improvements over this length.

(16) - *Al-khuwair Interchange Phase II*

The current Al-Khuwair roundabout on Sultan Qaboos Street serving the South Al-Khuwair development experiences regular congestion. During Phase I Construction of this interchange provisions have been made to allow in the future direct uninterrupted traffic movement between rest of the Muscat Area and South Al-Khuwair. This entails connection of the existing flyover with two additional south turning flyovers and establishment of a dual carriageway link 600 metres long crossing Al-Khuwair Wadi to South Al-Khuwair. The existing flyovers have been built with concrete stumps to allow the connection with the new flyovers. Additional ramps will also be provided to connect the existing roundabout and Qaboos City Street. The intermingling of the existing roads, buildings and wadi will entail complicated construction procedures. The existing wadi flowing on the eastern side of the roundabout will require realignment together with multi-cell box culverts for crossings, channels, slope protection for different drainage system. Restricted land-take will also mean extensive retaining of structures. The urban nature of the surrounding land will result in extensive demolition works.

### 5.3.2.3 - CATS PREFERRED NETWORK DEVELOPMENT STRATEGY

The testing and evaluation of alternative road network was carried out by the Consultant under three categories and time horizons:

i - Highway Network of the Capital Area Structure Plan, for the long term (post-2005)

ii - "Competing" Highway Projects, servicing similar traffic movements being mutually exclusive (also including equivalent links in the Structure Plan network), for the medium term (1995)

*Table 5.1* CATS Proposed Highway Projects

| Project No. | Project Title | Status | Base Year | Cost R.O (millions) | General Description | Comments |
|---|---|---|---|---|---|---|
| (1) | Proposed Link between Hamriya R/a to W. Kabir | Feasibility Study & Prelim. Design | 1985 | 14.72 | Construction of 2.7 km of dual carriageway with grade separated interchange | Relieve the severely congested existing roads and will improve accessibility |
| (2) | Wadi Adai Road dulling to Al-Amarat | Final Design | 1985 | 20.00 | 18 km dualling of Muttrah-Quriyat Road | To pass the existing severe traffic congestion and high traffic accidents |
| (3) | Wattayah R/a to Wadi Adai Roundabout improvement | Feasibility Study | 1985 | i - 0.70<br>ii - 1.13 | i - Addition of third lane to the existing road<br>ii - Construction of 2 km 2 single service roads | Severe traffic congestion |
| (4 ) | New Link From Qurum R/a to Nizwa Road | Final Design | 1983 | 51.80 | 40 km of dual carriageway, with all intersections are to be grade-separated | Provide an alternative route to the existing busy E-W corridor |
| (5) | New link Between Qurum & Wadi Adai R/a | Final Design & Tender Document | 1985 | 1.60 | Contraction of approximately 5 km single carriageway | Addition capacity to the east-west corridor |
| (6) | Muttrah Road upgrading and two new links | Feasibility Study & Prelim. Design | 1982<br>1985 | 23.42 | Construction of 3.6 km primary dual carriageway, culverts, street lighting and beautification | To improve the existing badly deeded traffic flow in Muttrah Area |
| (7) | Mina Qaboos Connector to Jibroo/ Qurum Hights R. | Preliminary Report | 1985 | 9.40 | Jibroo Re-development connector between Mina Qaboos and Jibroo Area , and storage Yard | Addition capacity and will relieve Al-Mina Street |
| (8) | Underpasses at Burg A'Sahwa R/a | Final Design & Tender Document | 1986 | 1.78 | Construction of underpasses at Burg A'Sahwa R. and dualling of first 5 km of Nizwa Road | To improve the major traffic flow congestion during the morning peak hours |
| (9) | Dualling of Nizwa Road within the Muscat Area | Feasibility Study | 1986 | 13.70 | 20 km dualling of Nizwa Road within the Muscat Area | To overcome the existing traffic congestion and traffic accidents |
| (10) | Wadi Kabir Service Road | Feasibility Study | 1980 | 2.41 | Construction of 6.7 km carriageway, street lighting and beautification | Affording minor relief to the main road and will improve accessibility |
| (11) | Seeb Municipality Road Network | Feasibility Study | 1985 | 45.23 | Development of 65 km of a new road network within the Seeb Municipality | Development to meet the exiting and the future needs |
| (12) | Boashar Al-Amarat New Link | Feasibility Study & Prel. Design | 1985 | i - 14.80<br>ii - 23.50<br>iii - 37.10 | i - 14.4 km surface route (2 lanes + climbing)<br>ii - 14.4 km surface route (4 lanes + climbing)<br>iii - 11.4 km tunnel route (3 km tunnel + 4 s.r) | To improve the accessibility to the Municipality and will provide relief the only link of Wadi Adai Road |
| (13) | Darsait Interchange Phase III and Jibroo S.R. | Final Design & Tender Document | 1985 | 3.50 | Construction of three level free flow interchange with service road to Jibroo (southern side) | Major improve to the existing traffic flow, time journey saving and accessibility |
| (14) | CBD South Storm Channel Crossing | Preliminary Design | 1985 | 0.52 | Contraction of single carriageway, culvert crossing street lighting, and beautification | Provide relief to the existing adjacent crossing |
| (15) | Dualling of Muscat-Bustan Road | Feasibility Study | 1983 | 9.10 | Upgrading 5.5 km of the existing Muscat-Bustan Road | Provide access capacity to meet future demand |
| (16) | Al-Khuwair Interchange Phase II | Preliminary Design | 1984 | 4.11 | Consists of 2 new bridges, ramps etc. and 600 of dual carriageway | Provide relief to the congested network in that area and will improve accessibility |

iii - "individual" Highway Projects, including preferred options of the competing projects, for the short term (1990)

The results of the testing and evaluation of alternative networks and highway options were used in establishing a preferred strategy for the development of the Muscat Area road network, including time-phasing and scheme priorities. The preferred network development strategy is summarised in *table 5.2*, where the highway projects are phased for the short and medium term (1990 and 1995 receptively). The schemes associated with the implementation of the Structure Plan highway network are also included for the long term(post 2005). The preferred network development strategy is illustrated in *figure 5.4*.

*Table 5.2:* CATS Preferred Highway Projects for Implementation

| Ref No | **Projects Descriptions** (see figure 5.4) |
|---|---|
| | **- Short Term (up to 1990)** |
| (1) | -- Link between Hamriya R/a to Wadi Kabir R/a (Road P1) |
| (2) | -- Dualling of Wadi Adai to Al-Amarat Road |
| (3) | -- Addition of third lane to Al-Nahda Street. |
| (4) | -- Link from Qurum Roundabout to Nizwa Road* |
| (5) | -- Link from Qurum Roundabout to Wadi Adai Roundabout* |
| (6) | -- Upgrading of Muttrah Road |
| (7) | -- New links to Jibroo and Cornish |
| (8) | -- Dualling of Nizwa Road within the Muscat Area |
| (9) | -- Underpasses at Burg A'Sahwa Roundabout |
| (10) | -- Wadi Kabir Service Road* |
| | **- Medium Term (1991-1995)** |
| (11) | -- Seeb Municipality Road Network* |
| (12) | -- Boashar to Al-Amarat link* |
| (13) | -- Darsait Interchange Phase III and Service Road to Jibroo |
| (14) | -- CBD South Storm water Channel Crossing |
| (15) | -- Dualling of Muscat to Bustan Road* |
| (16) | -- Al-Khuwair Interchange Phase II |
| | **- Long Term (1996+)**Remaining schemes in the CASP, |
| (17) | -- Completion of Southern Corridor. |
| (18) | -- Coastal Highway from Hail to Qurum (secondary road) |
| (19) | -- Fourth East-West Corridor from Qaboos City to Rusail |
| (20) | -- Lansab to Al-Amarat Link |
| (21) | -- Link from Burg St. R/a to Al-Nahda St. & to Southern Corridor |

* Schemes that revise the Capital Area Structure Plan Highway Network


*Figure 5.4:* Network proposals of the Capital Area Transport Study (1987)

### 5.3.3 - MUSCAT AREA STRUCTURE PLAN

The Muscat Area Structure Plan, Housing Study and Regional Plan were prepared by Weidleplan Consultants for the Ministry of Housing, 1989/91. These studies provided short, medium and long-term population projections, land use and housing development requirement by municipality.

According to the development strategy anticipated by the Muscat Area Structure Plan, there will be marginal growth in Greater Muttrah, moderate in Boashar and Al-Amarat and high in Seeb. As mentioned earlier, Greater Muttrah will be the Primary Centre and Seeb will be the Secondary Centre for future the Muscat Area. Accordingly, the major transportation development requirements are stated in the Structure Plan, as follows:

- i - Provision of another East-West rapid transit highway.
- ii - Provision of second Batinah Highway.
- iii - Improvement of accessibility to Al-Hajar Bowl.
- iv - Provision of a link between Rusail, where future residential and industrial development is anticipated, and Boashar.
- v - Implement the modified alignment of the Nizwa Road to protect the Ministry of Defence interest.
- vi - Improvement of circulation pattern and parking facilities in Seeb and Greater Muttrah

The highway network proposed by the Consultants is based on the Capital Area Transport Study without any testing or evaluation of alternative highway options according to the pattern and size of development within the Muscat Area. For some of the proposals, the consultants suggest certain modifications to their proposed alignment or priority. These major proposals are listed in *table 5.3*, including time-phasing and the estimated construction cost. while their location in relation to the exiting network and future land use are illustrated in *figure 5.5* .

| ***Table 5.3***: Muscat Area Structure Plan Road Network Implementation Programme | | |
|---|---|---|
| Ref.No | PROJECTS DESCRIPTIONS | Cost R.O (million ) |
| | **Phase I : 1991 -1995,** | |
| (1) | - Construction of Southern Highway -incl. Design + Feasi. Study | 25.000 |
| (2) | - Service Road at Wadi Kabir | 0350 |
| (3) | - Third lane from Wattayah R/a to Wadi Adai R/a | 0.250 |
| (4) | - Dualisation of Muscat-Bustan Road | 20.000 |
| (5) | - Construction of road Link from Wadi Kabir R/a to Hamriya R/a | 4.000 |
| (6) | - Dualisation of Nizwa R. (portion within the Muscat Area only) | 10.000 |
| (7) | - Dualisation of Wadi Adai to Al-Amarat | 4.000 |
| (8) | - Central Corridor Seeb | 2.000 |
| | - Greater Muttrah roads improvement | 7.400 |
| | - Greater Muttrah road strategic road network planning | 0.100 |
| | - Boashar roads improvement | 3.300 |
| | - Boashar road strategic road network planning | 0.600 |
| | - Seeb roads improvement | 3.900 |
| | - Seeb road strategic road network planning | 0.400 |
| | - Al-Amarat roads improvement | 5.300 |
| | - Al-Amarat road strategic road network planning | 0.250 |
| | - Muscat Area strategic road network planning | 0.650 |
| | - Long Term Transport Master Plan/update 1985 | 0.250 |
| | SUBTOTAL PHASE: I | **87.750** |
| | **Phase II : 1996 - 2000** | |
| (9) | - Construction of Boashar to Al-Amarat Road | 25.000 |
| (10) | - Qurum R/a towards Nizwa Road (Central Boashar Corridor R.) | 19.000 |
| | - Greater Muttrah roads improvement | 2.350 |
| | - Greater Muttrah road strategic road network planning | 0.020 |
| | - Boashar roads improvement | 9.600 |
| | - Boashar road strategic road network planning | 0.250 |
| | - Seeb roads improvement | 2.000 |
| | - Al-Amarat roads improvement | 2.100 |
| | SUBTOTAL PHASE: II | **60.320** |
| | **Phase III : 2001 - 2010** | |
| (11) | - Construction of Ghala-Ansab South Rusail Road | 11.000 |
| (12) | - Construction of Al-Hail to Adheiba Road | 1.000 |
| | - Greater Muttrah roads improvement | 2.600 |
| | - Seeb roads improvement | 1.750 |
| | SUBTOTAL PHASE: III | **16.350** |
| | TOTAL ROAD NETWORK INVESTMENT | **164.420** |
| Source : Muscat Area Structure Plan 1991 | | |

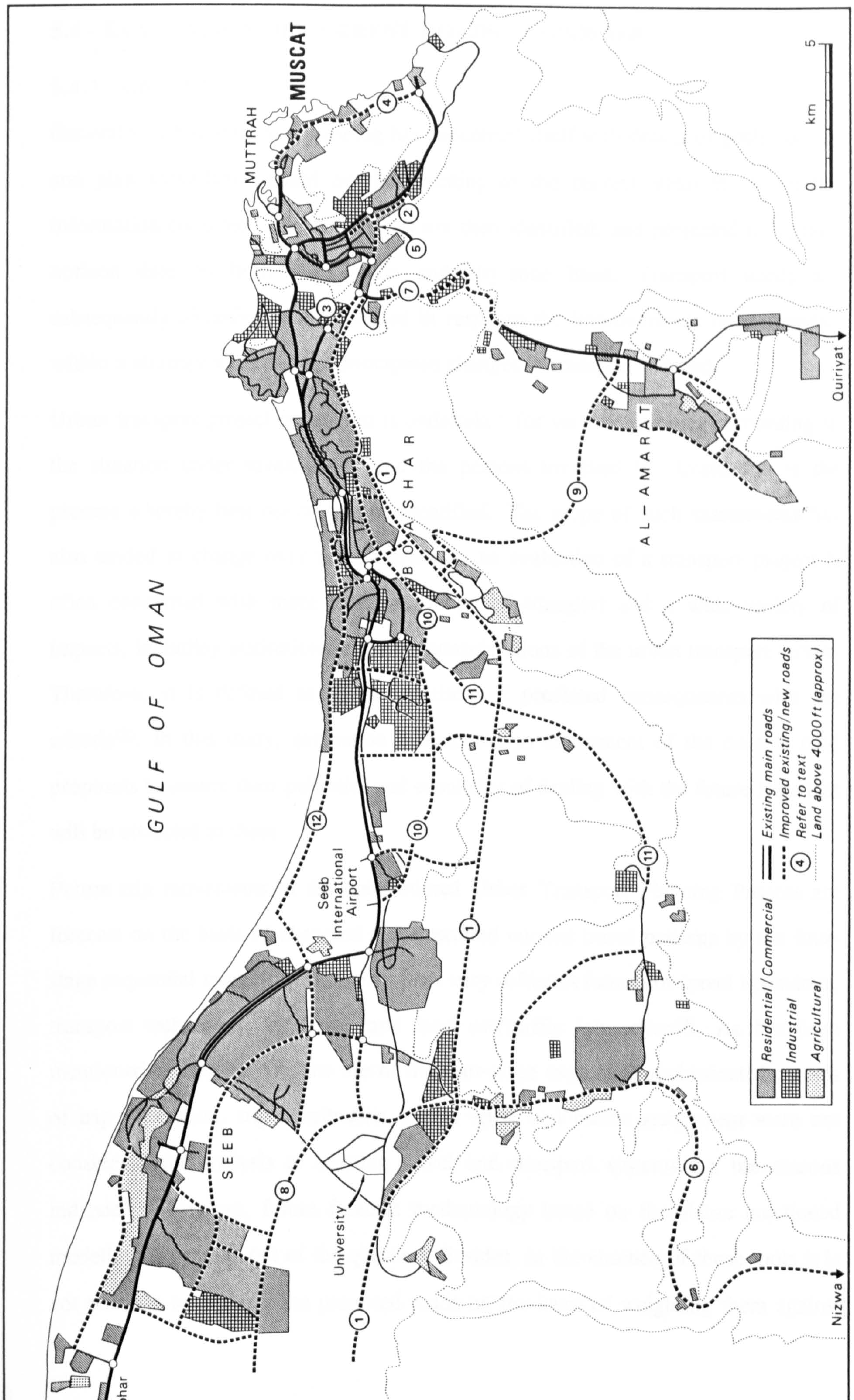



*Figure 5.5:* Network proposals of the Muscat Area Structure Plan (1992)

## 5.4 - EVALUATION OF CURRENT ROADS PROPOSALS

### 5.4.1 - *GENERAL*

Generally, urban transport planning has concerned itself with details of goals, policy and plan formulation based on data relating to the current situation. From the information collected, emerging trends are then identified, and projected to a given horizon date on both a city-wide and city-zone basis. Transport needs are subsequently identified, and evaluated in response the improvements recommended within a strategy so as to meet anticipated changes in transport demand.

Urban transport project evaluation is undertaken for various purposes, according to the situation under investigation and the persons involved (7). Evaluation is the process whereby best option can be identified. The scope of such assessments has also tended to change over time. Currently, an evaluation of a transport project is often concerned with more than one mode of transport and a wide variety of impacts, including institutional capacity considerations of the urban transport sector. Therefore, it is defined as the comparison of predicted consequences with the criteria(8). In this study, evaluation process means assessment of the current road proposals to ensure their priorities and capability of dealing with the future trips that will be attracted to them.

Future trip movements in the conventional Urban Transport Planning Process are forecast on the basis of observed and measured current travel patterns by the four-stage sequential models by assuming a not very different future for travel behaviour, transport technology, land use, and land use/traffic interaction(7). As has been mentioned in chapter one, the use of the four-stage sequential sophisticated models of trip generation, trip distribution, modal split, and traffic assignment were not considered for analysis of existing travel and transport systems for the reasons indicated. Therefore, future forecast methodology based on the above mentioned modelling process is out of the question. Besides, in the absence of those tools it is not possible to evaluate the proposed roads on the basis of weighting them against finance and other variables as in the conventional Urban Transport Planning Process.

In view of the limited time and resources available a very simple and straight-forward approach to travel forecasting is adopted, as an aid to demonstrate the future traffic demand and its impact on the existing and proposed road network. Therefore, the proposed roads evaluation includes:-

(i) - Evaluation of the proposed major road network currently under consideration in terms of their policies and implementation plans

(ii) - Simple future traffic forecast on the basis of future vehicles forecast, including future trip distribution in response to land use development, in order to demonstrate the scale of future traffic flow, without specifying the actual route or reference to travel mode.

5.4.2 - POLICIES AND IMPLEMENTATION PLANS EVALUATION

If the proposed road projects were implemented according to the previously mentioned studies, plans would improve the traffic movements and increase the accessibility within and into the Muscat Area. Most of these proposed road projects have not been implemented due to the fact that time-phasing and scheme priorities of these projects were not chosen carefully to fulfil the required demand within the maximum use of the available funds.

The current road proposals are based on the Capital Area Structure Plan road network proposals. The difference in some of the proposed road alignments came as an answer to some difficulties which emerged primarily during a detailed study of the proposed road. In the case of the Muscat Area Structure Plan road network, for example, the new alignment of the Southern Corridor was the result of the alignment of the corridor in the Capital Area Transport Study passing through the Ministry of Defence restricted land. For this reason, and to maintain the planned aim of the corridor, the new corridor alignment goes through a mountainous terrain which will reflect in a high construction cost, (*figure 5.5*).

One of the important points is that there is no balance in terms of priorities between the traffic demand and the proposed supply of road network within the funds available in the previous studies. As indicated earlier, time-phasing and scheme priorities of the road projects were not selected carefully to fulfil the required demand. Instead, the consultants devoted their efforts mainly to rearranging the 1982 road network proposals into three time-phasing programmes without any visible priority order per phase. This results in a very high investment in the road network which is beyond the road development budget allocated for the Muscat Municipality. In the absence of alternative efficient technical options these idealistic high investment programmes lost sight of what can be achieved within the limit of the available funds.

In view of the existing travel analysis and traffic flow observation, some of the road proposals have no significance to traffic flow or to accessibility improvement. As such, they are not shown to have justified their location in the short term or nor in the medium term plan, (e.g., dualisation of Muscat-Bustan road). There is no space here to fully examine each of the proposed roads in terms of their priorities to meet the demand in response to available funds. However, it is important to examine the Muscat Area Structure Plan preferred road options for the short term (1991 - 1995). This enables a direct comparison with the 1991 - 1995 overall budget of the Muscat Municipality.

As mentioned earlier (Chapter 4), Muscat Municipality is the agency with the overall responsibility for planning, construction and maintenance of all road network within the Muscat Area and other responsibilities(e.g. the provision of public services, car parking areas, recreation places, city beautification, etc. ...). It is also indicated, in the Fourth Five-Year Development Plan (1991-1995), that the sum of RO. 42.125 million (3.28% of the total government expenditure) was allocated to Muscat Municipality. Although, Muscat Municipality is the agency responsible for the Muscat Area road network, road development budget in Muscat Area has to be within the overall budget of the municipality.

Based on the Muscat Area Structure Plan, a sum of 764.014 millions Rial Omani has been estimated for the development programmes within the Muscat Area over the planning period of the next 20 years. Muscat Municipality has to invest a sum of RO. 316.380 million (41% of the Grand total) for the development plans over the three planning phases. Phase One costs RO. 169.220 million, Two RO. 91.410 and Three RO. 55.750 million. The share of the road network investment in each phase is 87.750 million, 60.320 million and 16.350 million respectively (see *table 5.3*).

The overall budget of 42.125 million for Muscat Municipality for the 1991-1995 development plan is insufficient to meet the spending demand of 169.220 million, nor will it meet the roads development expenditure demand of 87.750 million. Therefore a high percentage of the proposed plan has to be postponed. This is also the case in the Capital Area Transport Study whose first phase ended in 1990 with only part of one of the proposed road projects implemented (i.e. dualisation of part of Wadi Adai to Al-Amarat Road).

It is worth mentioning that Weidleplan Consultants under-estimated the cost of the proposed road projects which were already estimated in detailed studies (see *tables 5.1 and 5.3*).

### 5.4.3 - *TRAFFIC FORECAST*

The 528 households in the Muscat Area generate about 7,961 trips on a typical week day. These units housed 3,241 persons, at an average rate of 6.14 persons per household. The population living in these households reported using 650 vehicles. This is an average of 1.23 vehicle per household. In the course of an average weekday each person makes 2.99 trips and each vehicle makes 4.64 trips, (see Chapter 3).

The 1990 the Muscat Area Structure Plan estimated that the Muscat Area population will increase to 730,000 by the year 2010, representing an increase of 75 per cent over the population in 1990. For an average annual growth rate of 3.5 per cent, this is precisely equal to the national growth rate recorded for the Sultanate of Oman. At the same time, based on estimates of future passenger vehicle fleet by Girrb, Pettermuller and Partners for the feasibility study of Boashar-Al-Hajar Road in 1985(9), the Structure Plan estimates 325,000 vehicles in the Muscat Area in the year 2010. This, represents an increase of 160 per cent compared to 1990 total vehicle fleet of 126000, i.e. an average annual growth rate of 6.8 per cent.

In a different study by Dar Al-Handasah Consultants in 1984(10), it was estimated that the average annual growth rates in total vehicular traffic are in Oman, some 10 per cent up to 1985, 8 per cent up to 1990, and 6 per cent thereafter. The average annual growth rates in total vehicular traffic is 13 per cent for 1981 to 1986 and 12 per cent for 1986 to 1990 in the Muscat Area, while the average annual growth rate for asphalt roads in the Sultanate since 1980 accounts for 8.5 per cent, (Chapter 4).

In the assessment of road schemes it is necessary to take into account the increase in the number of vehicles which can be expected in the future. In particular it is the growth in the number and use of private cars which causes problems to the transport planner and the highway engineer working in urban areas(11). Muscat is no exception. The increase in the number of vehicles was 16.5 per cent in 1990, and the average annual growth rate has been estimated at 8.6 per cent for the next 20 years. The traffic growth rate is the highest among the above mentioned growth rates, reflecting the extensive use of private vehicles, (Chapter 3). Therefore, the estimated number of vehicles in the Muscat Area will be considered to estimate present and future traffic movements. The distribution of the estimated traffic among the municipalities is based on the Furness Method(12) in which the growth factors of trip generation and attraction are estimated on the basis of the research results in conjunction with the Muscat Area Structure Plan land-use strategy.

It is worth reiterating that such a traffic forecast is only for the purpose of demonstrating the scale of the traffic movements for the decision makers to appreciate the dimension of the traffic movement between the municipalities. One might well argue about the accuracy of the prediction and trip distribution method, because the forecasting process normally involves so many variables ( e.g. the estimating process might include trip rates for each of the of household or person categories, indicated by mode of travel - according to type of model applied, Chapters 2 and 3,).

However, as discussed previously, this study is more concerned with the diagnosis of the existing traffic conditions. Forecasting is a complicated process involving estimating parameters for traffic models and validating the performance of traffic models when these are applied in the real world. Such a process is beyond the researcher's time and resources. Therefore, the estimated traffic movements are demonstrated in terms of desire-line without a detailed description of the estimation procedure; hence avoiding unnecessary work, since the estimate itself does not attempt to give precise figures to avoid any misuse, (*figure 5.6*).

The prediction of the future traffic flow movements reveals higher numbers of long distance travel than in the existing movements. These variations can be seen from a comparison of the existing traffic flow movements (desire-lines) with the future flow movements. Therefore, it can be said that the future land-use development strategy will increase the number of long trips, hence it is necessary to develop the existing highway network to meet the future demand.

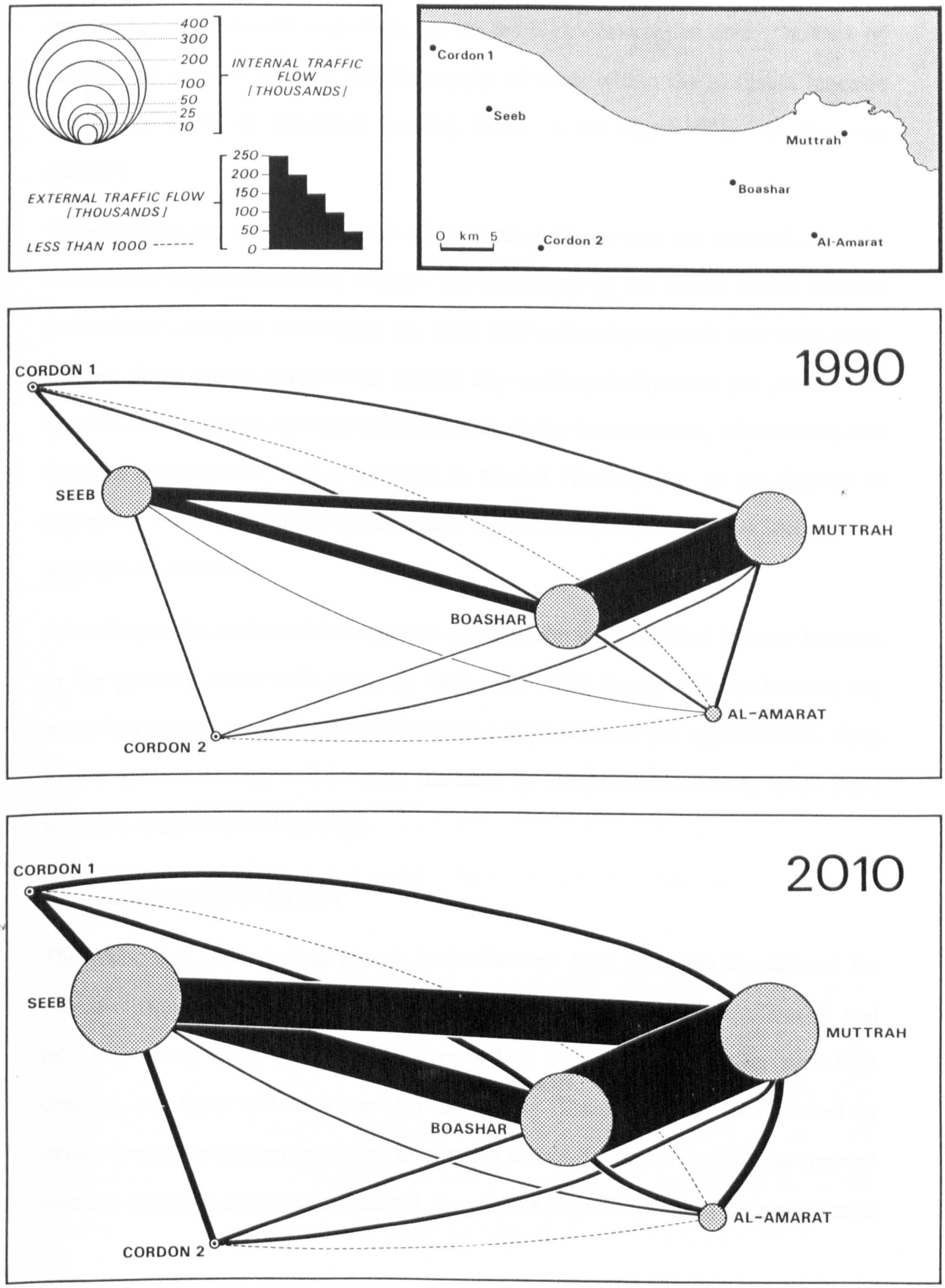



*Figure 5.6:* Traffic flow desire-line (1990 & 2010)

## 5.5 - CONCLUSION

The topographical features of the Muscat area create a significant constraint upon the improvement of the road network. This is reflected in the limited number of options for road network alignment and on the high construction cost. The lack of balance between the demand and the supply of roads within the available funds is considered to be an important limiting factor in the improvement of the road network.

Time-phasing and scheme priorities of the roads projects were not selected carefully to fulfil the required demand; instead, the consultants in the recent studies devoted their efforts mainly to rearranging the 1982 road network proposals into three time-phasing development programmes without any visible priority order per phase. This resulted in a very high investment programme in the road network, which is beyond the road development budget allocated to Muscat Municipality. In the absence of alternative efficient technical options these high investment programmes lost sight of what can be achieved.

According to the preferred development strategy, the importance of Greater Muttrah as the primary centre will continue. Seeb will grow significantly to become the secondary centre, while Boashar will attract a large share of job opportunities. Such a development strategy will increase the need for long distance travel, hence there will be a need for new highways.

## 5.6 - RECOMMENDATION

The social and technological growth in the Muscat Area increases the demand for effective transport facilities. Traffic management measures can be effective and relatively cheap to install, but cannot provide a total solution to meet such high demand, and there will be a need for new roads. These will only be achieved by longer term programmes involving investment in new transport facilities or through land-use planning development control. In practice a combination of both short term and longer term measures are desirable. The following measures may improve traffic movements in the Muscat Area.

### 5.6.1 - SAFEGUARDING ALIGNMENTS OF ALL ROADS PROPOSALS

It is understandable that once an alignment has been built upon it is very difficult and expensive to recover the ground lost for a new link in the road network. Therefore, the proposed options for the future road network alignments can be reserved and kept free from any development. This can keep the options open in terms of the future road network or at least until a comprehensive study has been carried out in order to identify the preferred future road network option, and to outline the policy for road network improvement agreed upon from all the authorities concerned.

### 5.6.2 - FUTURE LAND USE PATTERN

Muscat Area will develop mostly as a linear city with a primary centre in the east and a secondary centre in the west. As a result east-west movement over long distances will always be the most important characteristic of the traffic movement in the Muscat Area. In order to improve the east-west traffic movement it is important to establish suitable high speed corridors capable of handling large volumes of movement. To protect these corridors from local traffic and to avoid long-distance journeys, it is important to establish a hierarchy of service centres linked together by appropriate road network. The function of each urban centre would have to serve the intake population efficiently in accordance with the proposed hierarchy of urban settlement.

In order to encourage the hierarchy of urban settlement, future development can be directed towards a controlled spatial development reducing dispersal and concentrating public sector investments to generate homogeneous spatial units within the various levels of the settlement hierarchy. At the lowest level, each unit can contain sufficient commercial and public facilities for the area to be a self-contained community in order to minimise the use of motorised transport as much as possible. To avoid long-distance commuting as far as possible, future development of residential areas, wherever possible, can be directly linked to the development of job opportunity areas (e.g. industrial/ commercial areas).

At the highest level, Muscat Area is the capital and has to serve the whole country. Therefore, its structure should be representative at an international level, and its planning considerations should not be made in isolation from the development requirements of the other parts of the country. In order to discourage commuting into the Muscat Area, development policies in the other regions can be taken to improve the socio-economic conditions in each region to be self-contained.

### 5.6.3 - FUTURE ROAD NETWORK EXPANSION POLICY

The anticipated increase in the population in Muscat Area requires an expansion of the highway network to link new communities with established ones and to provide alternative arteries for traffic where existing facilities may soon reach full capacity. Substantial new highway construction has been proposed which can place a fairly heavy burden on the finances of Muscat Municipality. Concerning the future expansion of the network, emphasis will have to be given to the following criteria:-

(i) - The new road links have to serve, in an adequate manner, the population and their transport requirements. Therefore, the choice of routes and designs for new or improved roads and interchanges can be balanced with the traffic and accessibility needs and be justifiable.

(ii) - The new roads have to relieve the existing network and to complete it according to the priorities of the spatial structure, and if new alignment is required, it has to consider the urban development after 2010 in order to avoid new corridors becoming a barrier for future expansion or crossing potential future residential areas.

(iii) - The time-phasing of development programmes must correspond to the time periods of the Five-Year Development Plans, where the total investment programmes for major projects including transport expenditure are regularly planned by the government for the whole country.

(vi) - Priorities of road projects must be selected carefully in order to fulfil the required traffic demand within the anticipated available funds for Muscat Municipality on the sight of what can be achieved as one option. At the same time, it is essential to set up another priority scheduling of all the proposed road projects that can meet the existing and the future traffic demand effectively, and whenever deficits have been clearly identified additional funds can be budgeted from the central government.

### 5.6.4 - COMPREHENSIVE TRANSPORT STUDY

It is understandable that comprehensive transport planning cannot be achieved within the limited time and resources available for this research, besides, we cannot propose for the future without a vision of what will happen in the future. Therefore, it is necessary to update the existing Capital Area Transport Study in conjunction with recent studies by the Ministry of Housing, in order to integrate the transport planning process with land use planning process, through an updated comprehensive land use/transport study for the Muscat Area. Any updated transport study can make optimum use of the finding of the present study and other available information provided by other recent studies.

### 5.6.5 - AN ALTERNATIVE TO THE EAST-WEST CORRIDOR

The existing east-west corridor (Qaboos highway) forms the principal transport route throughout the Muscat Area and due to its location in the middle of the developed areas it will continue to perform this role in the future. No real alternative is apparent either to the south or along the coast, and there will always be a need for a major route acting as the spine of the Muscat Area and as the beginning of the national road network to all regions of the country.

In the light of the issues raised in Chapters 2, 3, and 4 concerning land use distribution, traffic flow and financial problems, priority could be give to the Coastal highway. Such a route can be an alternative to the existing east-west corridor and it can be considered as a first phase for some of the currently proposed road network. ( see Figure 5.7 )

The Coastal highway has the first priority in this study whereas in the Capital Area Transport Study and Muscat Area Structure Plan it is delayed to the third phase ( after the year 2000) to give priority to the Southern Corridor. However, the cost of the Coastal highway is significantly less then that of the Southern Corridor, (see table 5.3 for projects number 1 and 12). The cost of the Southern Corridor is so high that it can place a heavy financial burden on Muscat Municipality. Such a high cost already deterred the Municipality from considering the implementation of this Southern Corridor in CATS. Apart from the financial problem, the Coastal Highway will run along the coast which is the most populated area.

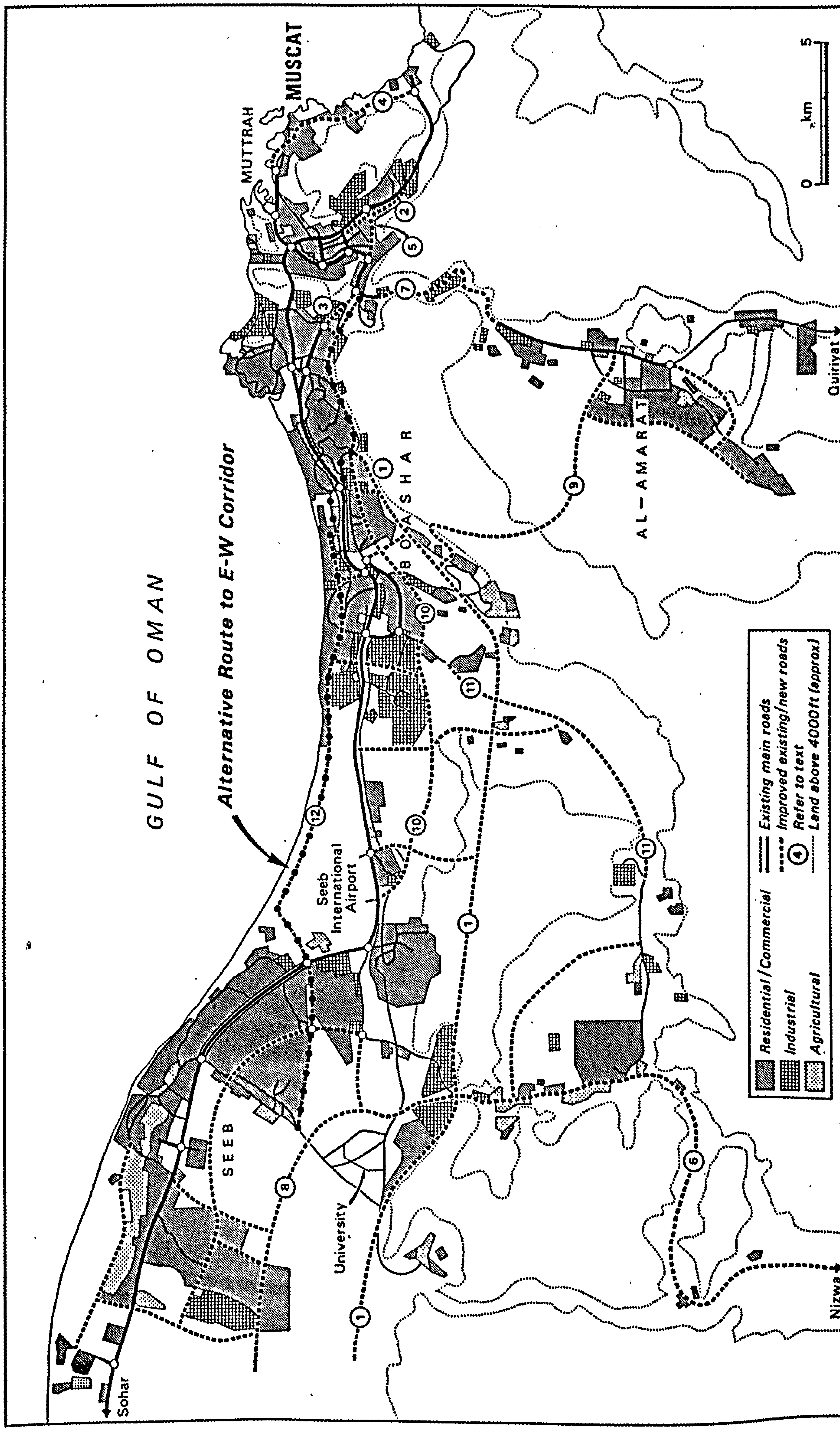



*Figure 5.7:* An alternative to Qaboos Highway

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# CHAPTER 6
# THE IMPACT OF THE MOTOR VEHICLE

## 6.0: INTRODUCTION

The world we live in today has seen tremendous technological development. The technology of today makes the life of mankind easier than ever before. One of the examples is the invention of motor vehicles. Cars are, without doubt, one of the most persuasive and intrusive technologies of the twentieth century(1). For decades the car has been seen as a response to demands for better living standards. Therefore, the motor car has become the primary means of transport. For this, roads are built, towns are planned and a high priority is given to meeting projected future demand and keeping traffic flowing and moving fast, everywhere(2).

The scale of land distances between Omani cities, and the lack of waterways and fixed track system have led to a heavy dependence on road capacity. Economic prosperity has given the opportunity to the public to possess their own private means of transport, which has resulted in a rapid increase in the number of vehicles in Oman, particularly in the Muscat Area. Although motor vehicles have advantages, there are also some disadvantages, namely traffic congestion, noise, pollution and traffic accidents.

The purpose of this Chapter is to investigate the environmental impact of motor vehicles in terms of traffic accidents, congestion, noise and air pollution. The emphasis is placed on studying traffic accidents in order to identify the factors that contribute to traffic accidents and to present appropriate suggestions that can help in reducing the number of accidents and providing guidelines for accident prevention, and management of the demand for road use.

## 6.1: TRAFFIC CONGESTION

The availability of the motor vehicle enhances accessibility, mobility and offers a wide choice of employment situations. It also increases the scope of recreational activities to a remarkable extent. At the same time it has consequences for the spatial location and activity patterns in the Muscat Area which result in considerable problems. The polluting effect of vehicle exhausts, the noise associated with road vehicles and above all the demands for physical space and very costly infrastructures, all make it necessary to control the use of vehicles in the Muscat Area.

The growth of motor car ownership, together with population increase, have allowed developments to be more dispersed than before, resulting in people living much further away from their places of work, shopping, education and leisure. Many new residential developments have been sited further away from the traditional centres of Muttrah and Muscat. These residential shifts later influenced the location of human activity to be dispersed all over the Muscat Area. Living away from one's work-place is a normal phenomenon in Muscat, thus, the number of trips and commuting distance have increased (see Chapter 3). Making these trips within the limited major roads that are subject to frequent jaywalking together with the lack of a clear separation between the fast and slow traffic lead to severe traffic congestion coupled with a high rate of traffic accidents.

Traffic congestion is a world wide problem. Cars demand physical space, especially in existing central areas, and this will always be greater than the supply because even if the necessary financial resources were available, there would be conflicting demands for the available land. The fact that the demand for road and parking spaces is greater than the supply results in traffic congestion(3). This problem was summarised by the Institution of Civil Engineers in the UK in 1989:-

> In fact traffic congestion is now itself acting as regulator of traffic. This is wasteful, costly and damaging growth, environment, convenience and increasingly so to public safety(4).

This is the case in Muttrah municipality, the primary centre of the country, where the topographical nature of the area limited the flat land required for housing, shops, schools and other facilities. One of the consequences of competition for space is that insufficient land has been allocated for roads and car parking in the major activity centres, leading to an acute shortage of parking spaces in these areas coupled with traffic congestion.

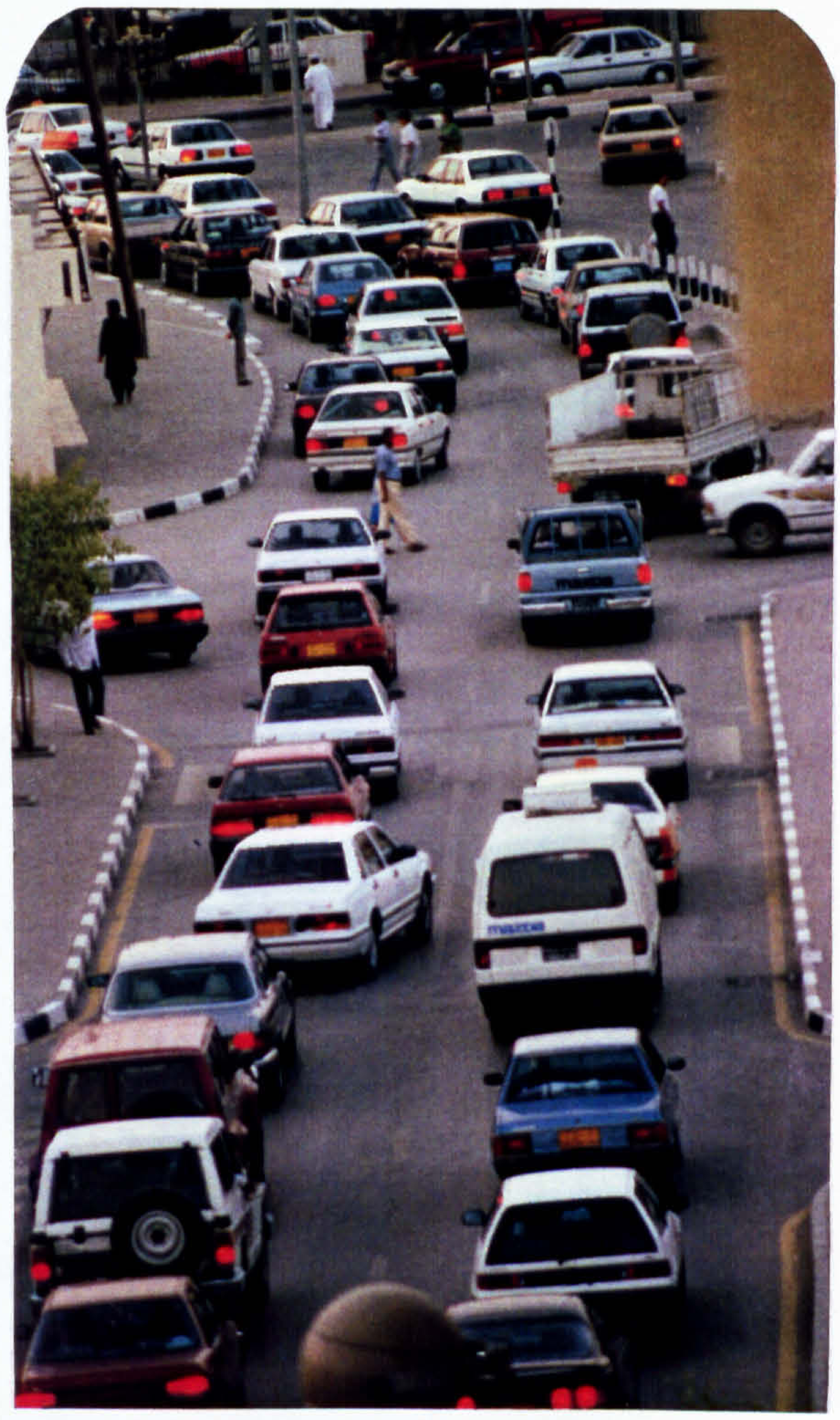
Traffic congestion in the Muscat Area is self-evident. The writer's resources and time-scale for the fieldwork were too limited to demonstrate the dimensions of the problem in statistical forms. *Plate 6.1* illustrates traffic congestion at various places in the Muscat Area. Traffic congestion is a direct result of economic growth, especially in Greater Muttrah, which is suffering from bad planning of early development when the pressure for new construction rapidly arose in Muscat Area during the first burst of intensive development in the early 1970s.

Present measures to reduce congestion are largely *ad hoc*. Solutions are commissioned for specific problems, junction improvements, bypasses, parking restriction, one way streets, no right turns and so forth. Such measures can successfully hold off congestion in some urban areas and may continue to do so. However, in major urban areas the scope for such measures is diminishing and it is likely that traffic will overtake any improvements. More radical approaches are required(4).

**6.2: TRAFFIC NOISE**

City life is movement. Physically this movement is transport, providing movement of persons and goods from one place to another. Motor vehicles are noisy; some are noisier than others. Highways traffic and lorries cause particularly serious disturbance. Physical measurements confirm that the intensity of traffic noise exceeds that of any other source over the greater part of urban areas(5).

B - Seeb Road



C - Ruwi Street

*Plate 6.1* Traffic Congestion - A- Hamriya Road Roundabout

The reasons for disliking noise are that it may be regarded as in itself unwelcome and unpleasant due to its interference with some wanted sound such as ordinary talk, teaching, telephone conversations, or, listening to music, radio, or television. It interferes with work performance, particularly where this requires mental concentration. It may make it difficult to sleep and it may have physiological effects. A report of the Department of Transport, UK (1970) stated the following about the traffic noise: -

> At the present time there is no reason to suppose that exposure under normal conditions to the noise from road traffic is in any way harmful to hearing even for protracted durations of exposure nor that it has any direct adverse physiological effects(6).

However, the noise of some heavy lorries can cause hearing loss to some drivers(7). At the present time road traffic noise is the most universal main source of transport noise. The chief variables determining the level of traffic noise are the composition of the traffic flow, the volume of traffic and traffic speed. Noise levels will be attenuated with the distance of the road from the point of measurement (or from affected houses and people). Noise levels are also influenced by the nature of the road surface and gradient. Peak noise levels at high speeds are higher on hot rolled asphalt or surface dressing such as that used in the highways than they would be on fine asphalt.

It is apparent from the foregoing discussion that traffic noise seriously reduces human quality of life on busy roads and in metropolitan areas generally, the Muscat Area being no exception. The concentration of government administration and the accompanying concentration of services, education, health care, social, cultural, welfare, economic and financial activities are located in the Muscat Area. Therefore, road traffic noise responds positively to such a very busy city with high concentration of various activities.

Although traffic noise is undoubtedly one of the most pervasive forms of noise, it seems to have received almost an undue amount of attention in most advanced countries. Government agencies and the city planners in the Muscat Area seem to be unaware or indifferent to the gravity of the problem and its effect compared to other priorities. The absence of road traffic noise information, identifying a particular noise reduction measure or field for treatment may lead to an incorrect judgement. Highlighting the potential measures for reducing road traffic noise nuisance in general terms might be beneficial in considering any appropriate improvement to the city environment.

There are a number of possible remedies for the road traffic noise nuisance, some of which apply to all types of transport noise. Some of the methods for reducing the impact of traffic noise are: (1) reducting the speed of vehicles, (2) reducting the traffic flow, (e.g. minimising unnecessary vehicle travel), (3) changing traffic composition, (4) changing vehicle technology, (5) changing road construction technology, (6) the use of sound barriers of different forms, and (7) separation of traffic noise from people by distance. The first five remedies to deal the source of noise while the last two are methods of lessening its impact. Noise could be reduced, but it would cost too much. Generally, one of the most promising methods of reducing traffic noise is improvement in technology. Existing lorries, cars and buses can be quietened to a limited extent, but major noise reductions involve redesigning engines and vehicles. The separation of people from traffic noise by distance is also an important remedial measure since other transport problems such as pollution and accident causation may also be avoided simultaneously.

### 6.3: AIR POLLUTION

Air is the cheapest and most valuable resource available to mankind[(8)]. During the last few decades, dependence on the use of petrol power for instance in transportation and industry and the use of atomic energy, have harmed the global atmosphere and polluted the air that people breathe. Air pollution is defined as:

> The presence in the atmosphere of substances or energy in such quantities and of such duration liable to cause harm to human, plant, or animal life, or damage to human-made materials and structures, or change in the weather and climate, or interference with comfortable enjoyment of life or property or other human activities[(9)].

The main pollutants associated with vehicles are carbon monoxide, nitrogen oxide, photochemical oxidants, lead, hydrocarbons, and other organic compounds such as aldehydes. The effects of this pollution have been reviewed by the Transport and Road Research Laboratory(10). Both petrol and diesel engines give rise to similar products in their exhausts but the relative proportions differ. Diesel engine exhaust gases contain significantly lower proportions of pollution than do those of petrol engines. An improperly operated or maintained diesel engine is liable to emit smoke and produce an offensive smell but even then, apart from carbon particles, the degree of pollution is less than that produced by petrol engines(3).

The Omani Ministry of Environment carried out a study to monitor seasonal trends of lead concentration in the air and the total of suspended particles in 1989 and found that there was no serious air pollution in Muscat Area(11). However, air pollution from vehicles is related to the size of the vehicle population, its driving characteristics (e.g. idling, cruising, accelerating, decelerating) and hence the amount of congestion. Measures to eliminate pollution will be measures which can reduce the size of the vehicle pollution and its driving characteristics as well as those technical measures which might be applied to vehicles themselves to minimise pollution from exhaust and engine system. Policies which encourage walking and public transport use, will contribute to improved air quality in the urban areas.

## 6.4: TRAFFIC ACCIDENTS

### 6.4.1 - *INTRODUCTION*

Road traffic accidents and their human casualties have been a major scourge in both developed and developing societies in the latter half of the twentieth century. Traffic accidents now rank high in any list of causes of deaths and serious injuries(12). Road traffic accidents are an increasing problem which has been extensively studied in developed countries. Few similar studies have been undertaken in developing countries, as the problem may at first seem relatively unimportant compared with the more immediate problems such as the lack of education and malnutrition(13).

Under the pressure of the high and rising toll of death, injury and material damage caused by traffic accidents, politicians and professionals in the developing countries are showing an increasing awareness of the need to find an adequate solution to this serious dilemma(14). In Oman, road accidents are a very serious phenomenon and their reduction requires the efforts of different organisations as well as road users' awareness of the causes of accidents.

The seriousness of traffic accidents in Oman is illustrated by the Directorate General of Traffic statistics which indicate that there were 37 accidents every day in 1991, which is an increase from 1971 when there was about one accident daily(15). On average, an accident occurred every 40 minutes in 1991, and more than 15 people were injured every day. The average death rate was about 1.2 persons per day which accounted for a death rate of 21.6 persons per 100,000 population and 182.9 person per 100,000 vehicles (see table 6.3). This high death rate could also be due to the lack of ambulance and rescue services. Despite a high standard of health service, first aid which involves quick and effective caring and transport of people from the site to the hospital is not available. There is no organised National Ambulance Service for the Muscat Area(16).

Traffic accidents have not been extensively studied in Oman, as the scale of the problem may at first seem insignificant compared with other needs such as improvements of public amenities. As a result of the continuously increasing number of traffic accidents, the Ministry of Communication appointed Misr Consulting Engineering in early 1991 to carry out a study in highway safety. Due to the fact that the Muscat Area road network is not within the jurisdiction of the Ministry of Communication, the black spots within Muscat Area were not included for treatment in this study.

A road traffic accident is a product of an unwelcome interaction between two or more moving objects, or a fixed and a moving object. The movement itself whether of pedestrians or motorists is a function of land use system. For example, residential patterns, population densities, street geometry, location of workplace, shopping precinct or other traffic generators(12). In other words, a road accident is defined as a rare, random, multifactor event always preceded by a situation in which one or more persons have failed to cope with their environment. This basic definition applies to every accident, no matter where, when or how it occurs or who is involved(17).

There is never a true accident situation in which something or someone can be said to be the cause of the accident. "Cause" in relation to road accidents is a global term covering a multiplicity of factors found in the circumstances leading up to the occurrence of an individual accident. Borener (1991) wrote about the difficulty to identify the actual causes of traffic accident: -

> One of the major obstacles to reducing accidents in the US. is that the underlying causes of traffic accidents are not clearly understood. Vehicle designs are in part responsible for some accidents. In addition, driver characteristics and the environment also influence the accident rate. Although it is simple to say that drivers, roads and vehicles are reasons for traffic accidents, their specific interactions are less predictable due to the complexity of the interactions(18).

However, the factors in each set of circumstances, regardless of how many or how few can be identified, broadly fall into three basic categories:

- (i) - Road Environment
- (ii) - Vehicle
- (iii) - Road User

These three main factors are basically considered responsible for traffic accidents. One of the factors could be the cause of the accident, such as a flat tyre, an obstacle on the road, or reckless driving. Two or more factors could combine together to cause an accident. In such a case, one factor alone may not lead to the accident without the presence of the other factors.

The police statistics on road traffic accidents give a perspective view of the total number of accidents, type of road and road user, and when and under what circumstances the accident occurred at the national level. The lack of information to identify geographically high-risk sites and accident information at the regional level, made it necessary to collect detailed information of injury accidents which occurred in the Muscat Area in 1991. For the purpose of analysis, the readily available aggregate data source was used to look at the entire problem, while the information collected during the fieldwork was considered in detail for the diagnosis of injury accidents that occurred in the Muscat Area. On the above basis the following section provides a somewhat detailed account of the intersection between the road environment, vehicle and the road user with the intention of recommending means of reducing and preventing traffic accidents.

### 6.4.2 - *ANALYSIS OF TRAFFIC ACCIDENTS IN OMAN*

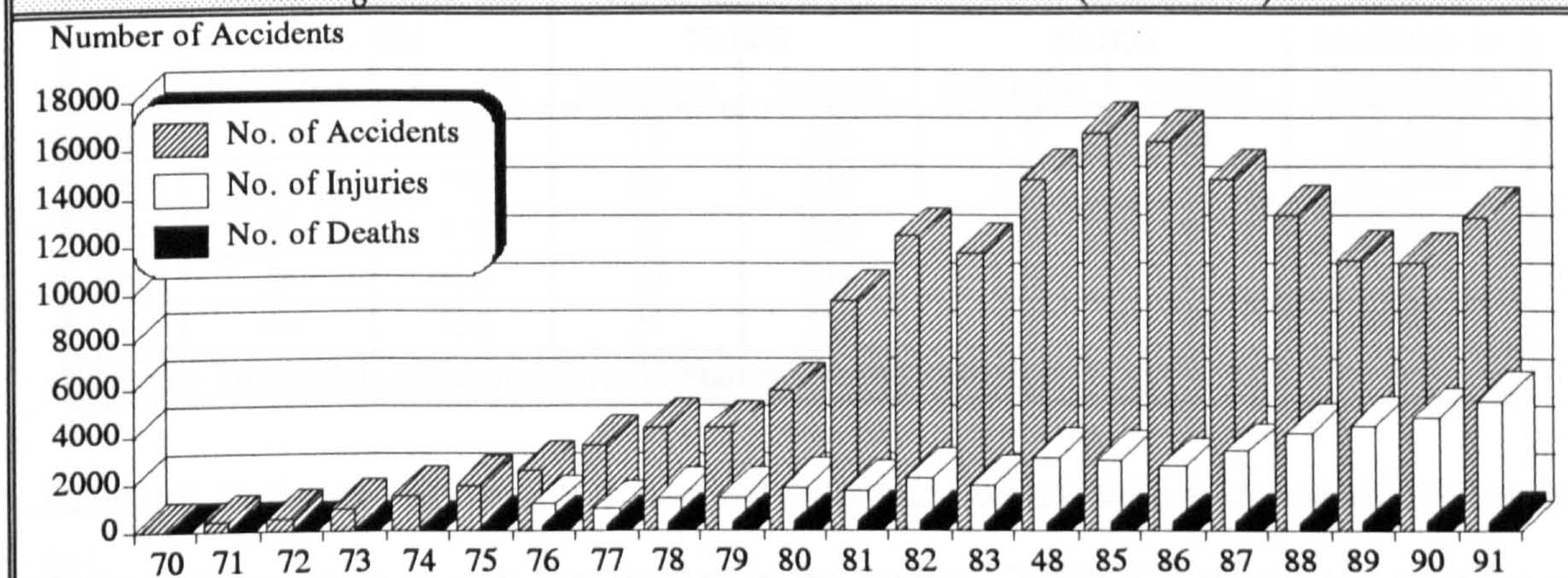
#### 6.4.2.1 - ROAD TRAFFIC ACCIDENTS 1970 - 1991

*Table 6.1 and Figure 6.1* show the number of traffic accidents and casualties during the past 20-years in Oman. It is evident that the number of accidents has increased steadily from only 383 in 1971 to 16,596 in 1985, and then decreased to 11,214 in 1990 and then increased again to 13,170 accidents in 1991. Over the past 20-years, the highest annual increase in the number of accidents was in 1981, with an increase of 3,785 accidents compared to 1980. The second highest was in 1984 with 3,092 accidents increase compared to 1983.

This considerable increase in traffic accidents and its variation during the past two decades reflects the growth of the economy and population of the country. As mentioned earlier, up to 1985 and especially during the early eighties, the economy of the country was booming due to high oil prices which resulted in many major development projects, including the improvement of the road network. The downturn in the oil prices in the 1985 and the country's recession that followed, contributed to the decline of traffic accidents, but, this could have been due mainly to the improvement of the road system in addition to the effect of the Traffic Week celebrated annually since 1985. The set-up of the country's economic growth coupled with no major increase in the highway network capacity show signs of increase in the number of traffic accidents.

Casualty accidents, which include both fatal and injury accidents, have also increased during the 20-year period, but do not follow the total traffic accidents path. Despite the decrease in the total number of accidents after the year 1985, the number of casualties is continuously increasing. The highest absolute number of casualties occurred in Oman in 1991 when 432 people were killed and 5,481 injured in road traffic accidents. It can be seen from the table that the death toll in 1983 declined, showing a remarkable decrease of 29.3 per cent in deaths compared to the previous year. This decrease could be due to the completion of the dualling of Al-Batinah Highway which was opened in 1983.

*Figure* and *Table 6.1:* Traffic Accidents in Oman (1970 -1991)




| Year | Number of | | | Year | Number of | | | Year | Number of | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Accident | Injuries | Deaths | | Accident | Injuries | Deaths | | Accident | Injuries | Deaths |
| 71 | 383 | N.A | 7 | 78 | 4304 | 1407 | 289 | 85 | 16596 | 2981 | 382 |
| 72 | 538 | N.A | 42 | 79 | 4265 | 1374 | 304 | 86 | 16269 | 2693 | 377 |
| 73 | 933 | N.A | 54 | 80 | 5849 | 1823 | 379 | 87 | 14708 | 3318 | 378 |
| 74 | 1515 | N.A | 55 | 81 | 9634 | 1732 | 406 | 88 | 13208 | 4072 | 359 |
| 75 | 1874 | N.A | 183 | 82 | 12356 | 2222 | 410 | 89 | 11655 | 4389 | 375 |
| 76 | 2550 | 1116 | 255 | 83 | 11631 | 1940 | 290 | 90 | 11214 | 4771 | 377 |
| 77 | 3559 | 953 | 228 | 84 | 14723 | 3081 | 345 | 91 | 13170 | 5481 | 432 |

Source: Directorate General of Traffic Statistics for 1985 -1991

### 6.4.2.2 - ACCIDENTS AND CASUALTIES RATES

Before examining the rates of accidents and casualties, it is worth comparing the growth of vehicles in relation to total accidents. *Figure 6.2* shows number of vehicles compared to the total number of accidents from 1987 to 1991. While the number of vehicles is increasing, the number of accidents is decreasing up to the year 1990. The decrease in accidents in Oman in spite of the increase in vehicles relates to the reasons mentioned earlier. Over the study period, the highest annual increase in the number of vehicles was in 1990, with an increase of 16.5 per cent in number of vehicles as compared to the previous year ( see Chapter 2).

Figure 6.2: Total number of vehicles compared to total number of accidents 1987-1991

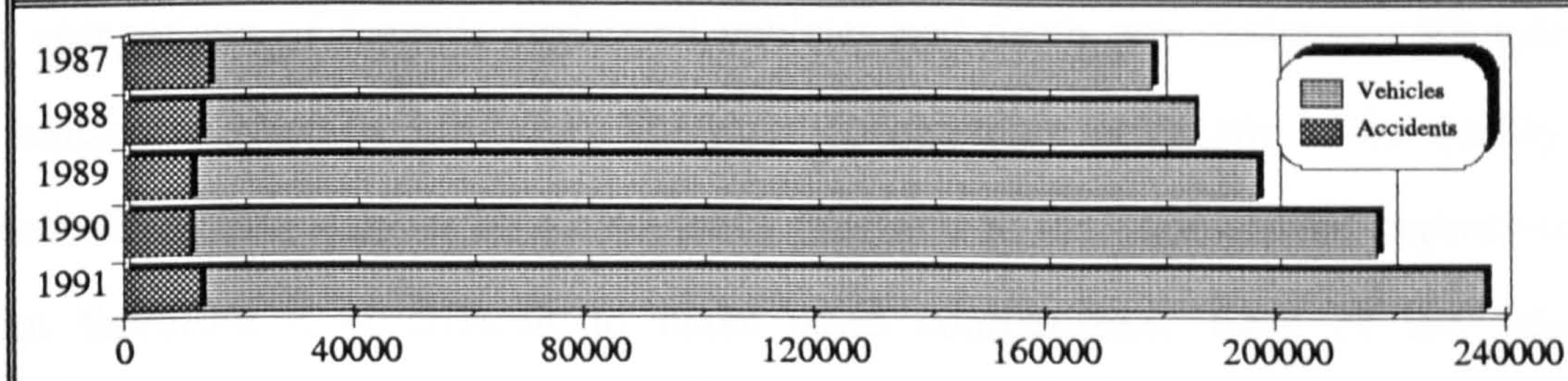



*Table 6.2*: Accidents and Casualties Rates

| Year | No. of Accidents per 10, 000 Population | No. of Accidents per 10, 000 Vehicles | No. of Injuries per 10,000 Population | No. of Injuries per 10,000 Vehicles | No. of Deaths per 10,000 Population | No. of Deaths per 10,000 Vehicles | Ratio of casualties to all accidents |
|---|---|---|---|---|---|---|---|
| 1987 | 74 | 823 | 16 | 186 | 1.9 | 21 | 25.10% |
| 1988 | 66 | 710 | 20 | 219 | 1.8 | 19 | 33.50% |
| 1989 | 57 | 578 | 22 | 223 | 1.9 | 19 | 41.40% |
| 1990 | 56 | 516 | 24 | 219 | 1.9 | 17 | 45.97% |
| 1991 | 66 | 558 | 27 | 232 | 2.2 | 18 | 44.90% |

Source: Directorate General of Traffic Statistics for 1987 -1991

Accident statistics are usually converted into rates which take into consideration the degree of exposure to risk that occurs in the events. *Table 6.2* shows the number of motor vehicle accidents and casualties as related to population. The accident rate, however, showed an improvement and decreased from 74 in 1987 to 66 per 10,000 population in 1991. The death rate reached a peak of 2.2 deaths in 1991 and showed an increase of about 16 per cent over the 5-years period. The injury rate also shows an increase of 25 per cent between 1987 and 1991. The motor vehicles accidents and casualties were also related to vehicle registrations. The death rate decreased during the study period from 21 to 18 people per 10,000 vehicles, while the number of accidents per 10,000 vehicles decreased from 823 to 558 and the injury rate increased from 186 to 232.

It can be noted from the table that the percentage of human casualties (fatalities and injuries) to the total number of accidents in the 1991 was 44.9 as compared to 25.1 per cent in the 1987. This is despite the fact that the number of accidents to the number of registered vehicles decreased from 8.2 per cent in the year 1987 to 5.5 per cent in 1991. This may indicate that the consequences of accidents in Oman are becoming more serious.

### 6.4.2.3 - INTERNATIONAL COMPARISONS

A comparison of Oman's registered vehicles and death rate statistics with selected countries is given in *table 6.3.* There are considerable variations in the quality and method of estimation of traffic statistics provided to the international organisations, and therefore it is difficult to make valid comparisons. Each of the selected countries is a unique nation and, therefore, the fatality rates of different nations must be treated with considerable care, as they can contain results arising from such diverse factors as differing traffic composition, variations in the proportion of travel occurring in built-up areas, and different qualities of street lighting, highway standards, vehicle legislation, etc. Furthermore, the accident reporting procedure can be very different, (e.g. in Oman, a road fatality is described as being due to a road accident if death occurs within thirty days; in Italy, seven days; in France, six days; in Japan, one day; whilst, in Portugal, a road fatality is only considered to occur at the scene of the accident or immediately afterwards[(19)]).

Accident fatality rates are more useful if they are represented in terms of vehicle-kilometres driven, which were not available for the writer for most of the countries, particularly for Oman. Therefore, the fatality rates are illustrated in terms of number of deaths per 100,000 population and per 100,000 vehicles. It was recognised that the fatality rate per 100,000 population does not show the true picture of the severity of traffic accident death occurrence, since different countries

*Table 6.3* : Motor-Vehicle Deaths, Rates, and Vehicle-Registration in Selected Countries

| Country | Motor-Vehicle Traffic Deaths | | | | 1988 Vehicle Registration | | | |
|---|---|---|---|---|---|---|---|---|
| | Year | Number of Deaths | No. of Death per 100,000 ... Population | Vehicles | All Vehicles | Population per Vehicle | Passenger Cars | Population Per Car |
| - Sweden | 1987 | 764 | 9.10 | 20.30 | 3,764,043 | 2.20 | 3,482,656 | 2.40 |
| - U.S.A. | 1987 | 47,297 | 19.40 | 25.60 | 184,396,732 | 1.30 | 43,145,037 | 1.80 |
| - Canada | 1987 | 4,180 | 16.30 | 26.40 | 15,860,000 | 1.60 | 11,900,000 | 2.10 |
| - Finland | 1987 | 537 | 10.90 | 26.40 | 2,034,166 | 2.50 | 1,811,300 | 2.80 |
| - Japan | 1988 | 13,420 | 11.00 | 25.60 | 2,034,166 | 4.30 | 30,776,243 | 4.00 |
| - Switzerland | 1988 | 957 | 14.50 | 29.80 | 3,207,421 | 2.00 | 2,761,282 | 2.30 |
| - Australia | 1988 | 3,078 | 18.60 | 33.40 | 9,221,000 | 1.70 | 7,243,600 | 2.20 |
| - Italy | 1986 | 9,329 | 16.30 | 39.70 | 23,500,000 | 2.30 | 25,480,000 | 2.40 |
| - New Zealand | 1986 | 762 | 23.20 | 40.75 | 1,870,000 | 1.80 | 1,555,000 | 2.20 |
| - France | 1988 | 10,165 | 18.20 | 40.10 | 25,352,000 | 2.20 | 22,370,000 | 2.50 |
| - Puerto Rico | 1986 | 618 | 17.60 | 40.70 | 1,518,544 | 2.20 | 1,294,904 | 25.00 |
| - Spain | 1985 | 5,670 | 14.70 | 44.10 | 12,860,282 | 3.10 | 10,787,424 | 3.70 |
| - Argentina | 1985 | 2,628 | 8.60 | 46.30 | 5,680,000 | 5.70 | 4,186,440 | 7.80 |
| - Czechoslovakia | 1988 | 1,643 | 10.50 | 47.50 | 3,460,678 | 4.50 | 2,999,987 | 6.30 |
| - Kuwait | 1987 | 343 | 18.30 | 59.30 | 578,500 | 3.40 | 464,000 | 4.20 |
| - Singapore | 1987 | 233 | 8.90 | 63.20 | 368,815 | 7.20 | 251,414 | 11.00 |
| - Greece | 1987 | 1,869 | 18.10 | 84.30 | 2,215,923 | 4.50 | 1,507,452 | 6.70 |
| - Hong Kong | 1987 | 283 | 5.00 | 87.40 | 323,630 | 18.00 | 195,326 | 29.00 |
| - Portugal | 1988 | 2,824 | 27.50 | 161.80 | 1,745,000 | 5.90 | 1,340,000 | 7.60 |
| - Oman | 1991 | 432 | 21.60 | 182.88 | 185,967 | 10.75 | 122,185 | 16.37 |
| - Thailand | 1987 | 4,441 | 8.30 | 199.80 | 2,222,825 | 25.00 | 815,825 | 67.00 |
| - Ecuador | 1988 | 1,729 | 17.40 | 785.90 | 220,000 | 48.00 | 60,000 | 175,00 |
| Comparion between the Muscat Area and the Whole Country using 1990 data | | | | | | | | |
| - Muscat | 1990 | 73 | 17.49 | 68.70 | 106,253 | 3.90 | 87,127 | 4.80 |
| - Oman | 1990 | 377 | 18.85 | 173.70 | 217,463 | 9.20 | 115,702 | 17.20 |

Sources: 1 - "Accidets Facts" 1990 Edition, National Safety Council, U.S.A. 2 - Directorate General of Traffic " Annual Statistical Book 1991" 3 - Development Council " Annual Statistical Book 1990" Sultanate of Oman have different car ownership rates and consequently different vehicle-kilometres driven each year. For this reason, the death rates per 100,000 vehicles are calculated and represented by the writer in order to mark the scale of accident death rates in consideration to the number of population and registered vehicles. The ratios of population to vehicle indicate the relative mobility or dependence of the population on the motor vehicle as means of transportation.

*Table 6.3* shows that Oman has one of the highest fatality rates per registered vehicles and per population. Therefore, these high rates confirm the urgent need for efficient measures to be taken to reduce number of accident deaths in conjunction with overall policy for traffic accident reduction.

A comparison of the Muscat Area registered vehicles and death rates statistics with the whole country are also given in table 6.5. It can be noted that the numbers of deaths rates in both cases are lower in Muscat Area, reflecting the effect of urban areas and the high rate of car ownership in reducing the death rates particularly per registered vehicles. In addition, it reveals the importance of vehicle-kilometres driven in representing the true picture of traffic accident death rates.

### 6.4.3 - *ANALYSIS OF TRAFFIC ACCIDENTS IN MUSCAT AREA*

#### 6.4.3.1 - GENERAL

As mentioned earlier, the police statistics on road traffic accidents give a perspective view of the total number of accidents at the national level. The lack of information to identify the high-risk sites and accident details at the regional level, made it necessary to collect information on casualty accidents occurring in the Muscat Area from the police files. Therefore, casualty accidents which occurred in the Muscat Area and reported to the Police for the year 1990 were analysed, giving a total sample of 706 accidents. This figure excludes about 5 per cent of the records that lack information, (e.g. driver escapes). The following information was taken from each record:

(i) - time of accident ( hour, day and month);

(ii) - type of accident (collision, run-over pedestrian, over-turn and collision with fixed body);

(iii) - type and number of vehicles involved, and type of impact;

(iv) - degree of injury ( fatal, serious, medium, slight and non-injured);

(v) - type and classification of road;

(vi) - age, sex, occupation, nationality and casualty location; and

(vii) - location of the accident, visibility and weather condition.

The analysis reveals that of the 706 injury accidents 35 per cent were cases of collision between two or more vehicles, which often results from lack of correct estimation of the distance between vehicles or drivers failing to stop at road junctions when the traffic priority is for other vehicles. A large proportion of injury accidents in the Muscat Area (44 % of total) involve pedestrians. Both the driver and the pedestrian may share the responsibility; the former through driving too fast and the latter through inattention when crossing the road. This type of accident tends to occur in busy areas where there are no pedestrian facilities, particularly along the main roads. Over-turned vehicles account for 11 per cent of injury accidents, possibly due to a blow out or puncture when travelling at speed. Vehicles crashing into fixed bodies account for 10 per cent of the total.

When the injury accidents were examined in terms of the number of casualties, 66 people were killed, 1054 injured and 641 non-injured, totalling 1761 people. Of the 1054 injured, 78 people were seriously injured, 316 moderate and 660 slight. As for the effect of the weather on the number of injury accidents, 96 per cent occurred in clear weather. Other types of weather conditions accounted for only 6 per cent. Sixty five per cent of the drivers and passengers casualties were wearing seat-belt. Of the 35 per cent of non-seat-belt users, 92 per cent were passengers and only 8 per cent were drivers. Only 4 drivers out of 998 drivers involved in accidents did not have a driving licence.

As for the nationality of people involved in accidents, 29 per cent were non-Omanis. Those form 35 per cent of the total population in the Muscat Area[20].

When non-Omani people involved in accidents were separated in terms of casualty class, it was found that 62 per cent were drivers, 22 per cent passengers and 16 per cent pedestrians. For Omanis the figure were 55 per cent, 25 and 20 per cent respectively. With respect to occupation of people involved in accidents, 12 per cent were students, 44 per cent were government employees, 18 per cent were private employees, 3 per cent were self employed and 23 per cent were unemployed persons. These proportions vary significantly when they are considered in terms of the Muscat Area population, as previously seen in chapter 2 (39% students, 20% government, 14% private, 3% self and 24% unemployed). The following sections provide more detailed analysis for the other aspects of traffic casualty accidents in the Muscat Area. Casualty location, vehicle type, and type and classification of road data were considered unreliable and they were therefore not included in the analysis.

### 6.4.3.2 - CASUALTY BY AGE AND SEX

As mentioned earlier, in the 706 injury accidents that occurred in the Muscat area, 66 people were killed, 1054 injured and 641 non-injured, totalling 1761 people. Of the total, 998 of accidents involved were drivers, 433 passengers and 330 pedestrians, representing 56 per cent, 25 and 19 per cent respectively. When the people involved in the accidents were separated in terms of sex, 80 per cent were males and only 20 per cent were females. Only 12 per cent of the females involved in the accidents were non-injured. The non-injured males accounted for 42 per cent of all involved. Female drivers make up 9 per cent of the total drivers.

The distribution of all accidents involved by age group shows that the children of 6 years of age or younger account for 6 per cent of all people involved, and children from 6 to 17 years account for 11 per cent. People from 18 - 25 years of age account for 32 per cent and from 26 - 50 years account for 48 per cent, and people over 50 years of age account only for 4 per cent. The age of the driver plays a significant role in road traffic accidents. Drivers between the ages of 18 and 25 account for 41 per cent of the total drivers involved in accidents. This in part reflects the high rate of car ownership among this age group, and, as explained by some researchers, the lack of experience in some cases and their willingness to take risks(21).

*Table 6.4* shows accident casualties by age group in terms of sex and severity of injury. The 26 - 50 years age group has the highest number of casualties with 43 per cent, followed by the 18 -25 years age group, 27 per cent. Approximately 52 per cent of the females who were injured or killed belonged to the 18 - 25 years age group. Youngsters of 17 year of age or younger account for 50 per cent of all pedestrians involved, while females passengers aged from 26 to 50 years account for 48 per cent of all female passengers casualties.

*Table 6.4:* Type of Accidents Casualties in 1991

| Persons | | 1 - 6 years | | 7 -17 years | | 18 - 25 years | | 26 -50 years | | Over 50 | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Class | Severity | M | F | M | F | M | F | M | F | M | F | |
| Driver | Fatal | 0 | 0 | 0 | 0 | 4 | 1 | 3 | 1 | 0 | 1 | 10 |
| | Serious | 0 | 0 | 1 | 0 | 12 | 1 | 16 | 0 | 2 | 0 | 32 |
| | Moderate | 0 | 0 | 2 | 0 | 32 | 8 | 38 | 4 | 3 | 0 | 87 |
| | Slight | 0 | 0 | 5 | 1 | 81 | 14 | 117 | 12 | 2 | 0 | 232 |
| Passengers | Fatal | 1 | 1 | 1 | 1 | 3 | 1 | 8 | 2 | 2 | 0 | 20 |
| | Serious | 0 | 2 | 2 | 2 | 4 | 0 | 5 | 4 | 0 | 0 | 19 |
| | Moderate | 2 | 5 | 16 | 8 | 24 | 6 | 28 | 23 | 1 | 4 | 117 |
| | Slight | 5 | 17 | 30 | 15 | 41 | 44 | 54 | 62 | 4 | 5 | 277 |
| Pedestrians | Fatal | 4 | 1 | 1 | 1 | 2 | 0 | 17 | 1 | 7 | 2 | 36 |
| | Serious | 0 | 1 | 5 | 2 | 4 | 0 | 8 | 2 | 2 | 0 | 24 |
| | Moderate | 13 | 13 | 22 | 7 | 10 | 0 | 31 | 7 | 10 | 1 | 114 |
| | Slight | 33 | 11 | 30 | 18 | 8 | 1 | 39 | 4 | 8 | 0 | 152 |
| Total | | 58<br>5.2% | 51<br>4.6% | 115<br>10.3% | 55<br>4.8% | 225<br>20.0% | 76<br>6.8% | 364<br>32.5% | 122<br>10.9% | 41<br>3.7% | 13<br>1.2% | 1120<br>100% |

Source: Data collected from the Police Files, During the fieldwork trips in 1990 & 91

### 6.4.3.3 - FACTORS CONTRIBUTING TO INJURY ACCIDENTS IN MUSCAT

Studies conducted in both developed and developing countries show that the human element is the main cause for traffic accidents (about 85 per cent of the total number of accidents). The vehicle and road represent only 15 per cent(22).

Accident results differ from one country to another depending on the efficiency of both the urban and rural road networks, the mechanical condition of the vehicles, the degree of discipline of the average citizen concerning traffic laws and regulations, and the capability of the traffic department of each country to enforce the law on violating drivers and to carry out accurate analysis of traffic accidents to identify the real cause that will eventually reflect on the results of the statistics .

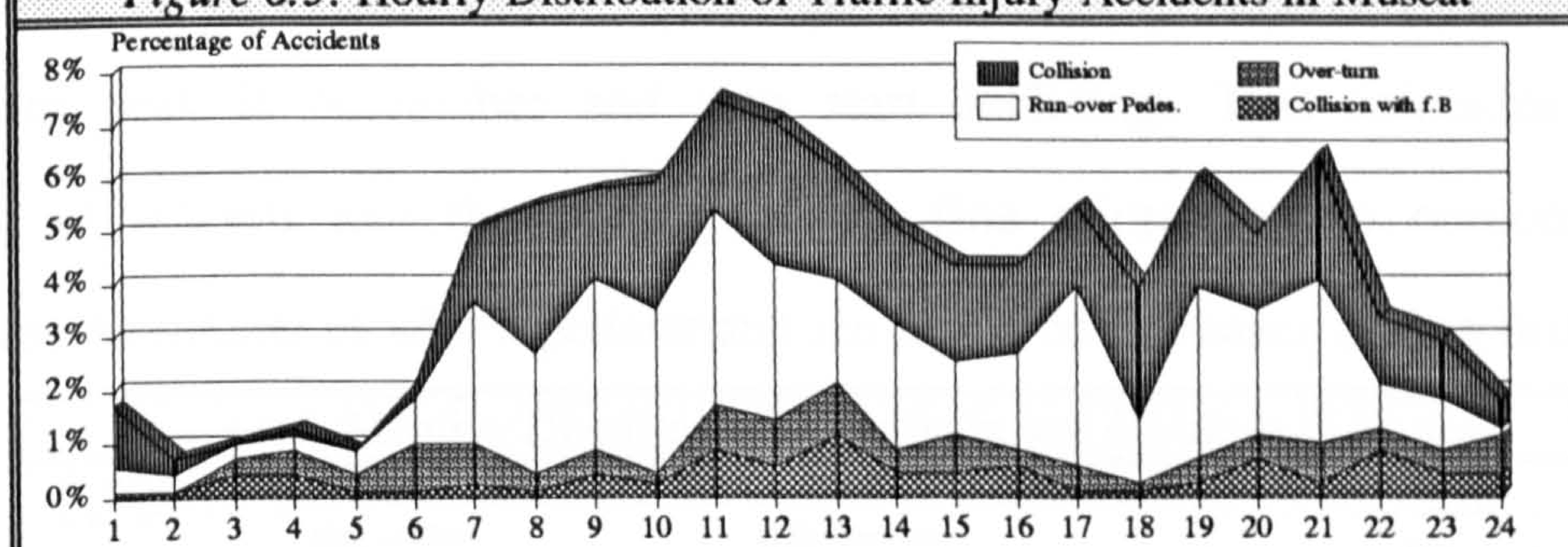
The statistics in Oman show that the road users were wholly or partly responsible for more than 99 per cent of accidents which occurred in the whole country in 1990, while the road environment and vehicle accounted for less than 1 per cent when acting independently or in a combination. In the case of the injury accidents occurring in the Muscat Area these figures are quite compatible. Road users were responsible for 98.6 per cent of injury accidents, while the road environment and vehicle accounted for 1.4 per cent. Therefore, it can be said that Oman is one of the countries where the human factor is the major cause of accidents. This high contribution of human factor to traffic accidents could be due to excellent engineering standards of the road network coupled with a high technical condition of the vehicles or the lack of qualified investigators to identify clearly the true causes of the accident on-the-spot.

When the road users who were involved in accidents are separated in terms of accident cause, the most common reasons for accidents are: negligence (65.0%), speeding(21.1%), bad driving(8.4%), alcohol(5.8%), and fatigue and psychological factors (1.7 % together). It would assist in targeting the worst abuses of the road if the police reports did include the types of negligence or the classification of the road users who caused the accidents in order to identify who was responsible (driver, pedestrian). The reports also did not identify bad driving. Most of the driving procedures and several traffic violations could be listed under the general understanding of this terminology, where a traffic awareness planner needs a clear identification of each human error to enable him to develop an appropriate remedy to each mistake, bearing in mind that treatments differ according to age, sex, level of education, and social class of the recipient. Speed is the second highest contributor to injury accidents in Muscat Area. Therefore, it is vital that drivers keep the speed limit. Length of the stopping distance increases with speed, so travel at a safe speed is necessary for drivers to control their vehicles.

### 6.4.3.4 - HOURLY DISTRIBUTION

The combined weekday and weekend hourly distribution of traffic injury accidents according to type of accident in the Muscat Area is shown in *Figure 6.3*. Peaks in injury accidents coincide with the working, shopping and recreation rush-hours(see Chapter 3). The effect of visibility on injury accidents is reflected in that 75 per cent of the casualty accidents occurred during daylight and 25 per cent occurred at night. Accidents which occurred at night were found to be more in the form of vehicles crashing into fixed bodies. This could be the result of poor street lighting or inadequate headlights, leading to poor visibility.

*Figure 6.3*: Hourly Distribution of Traffic Injury Accidents in Muscat

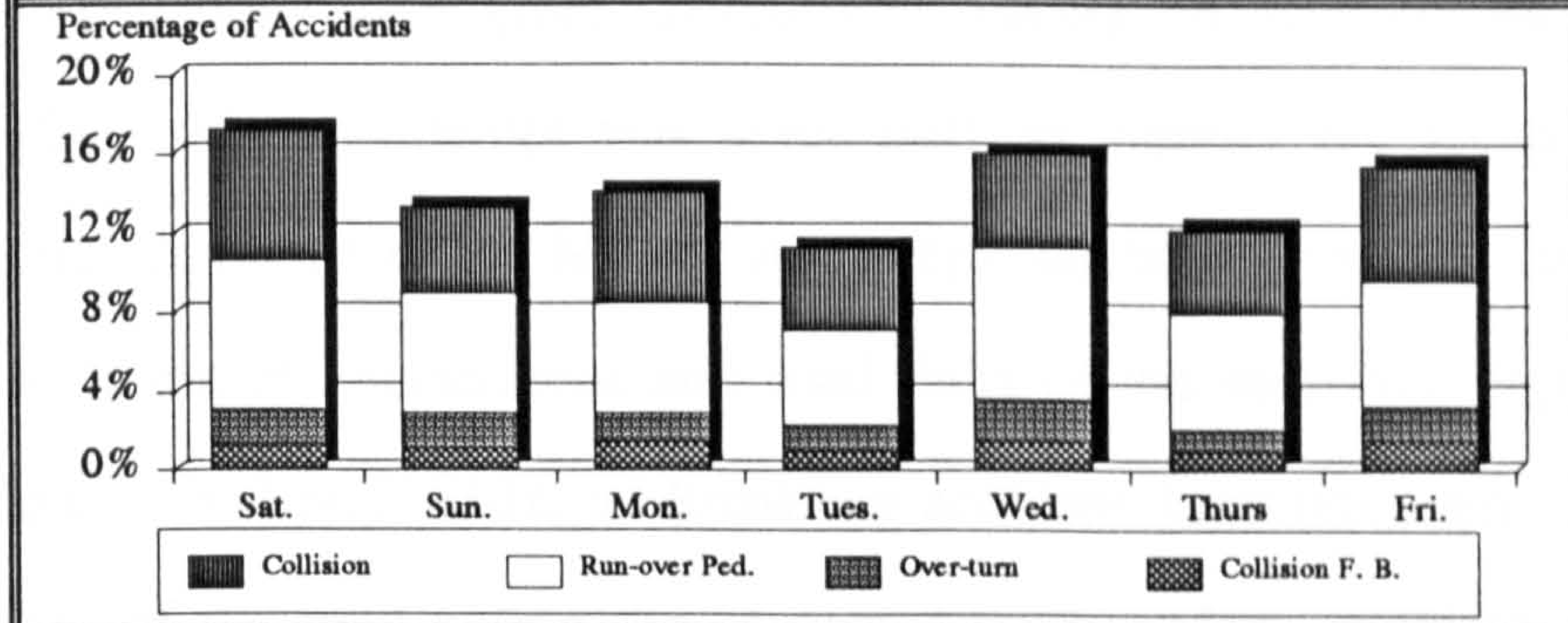



Source: Data collected from the Police Files, During the fieldwork trips in 1990 & 91

### 6.4.3.5 - DAILY DISTRIBUTION

*Figure 6.4* indicates the daily variation of road injury accidents in the Muscat Area according to type of accident. More than 17 per cent occur on Saturday, followed by Wednesday with about 15 per cent of the total injury accidents. The minimum number of accidents occur on Tuesday, which accounted for 10 per cent. Saturday and Wednesday in Oman indicate the first and last days of the working week. There is no significant variation in terms of type of accidents occurring either during the working days or during the weekend.

*Figure 6.4*: Daily Distribution of Traffic Injury Accidents in Muscat

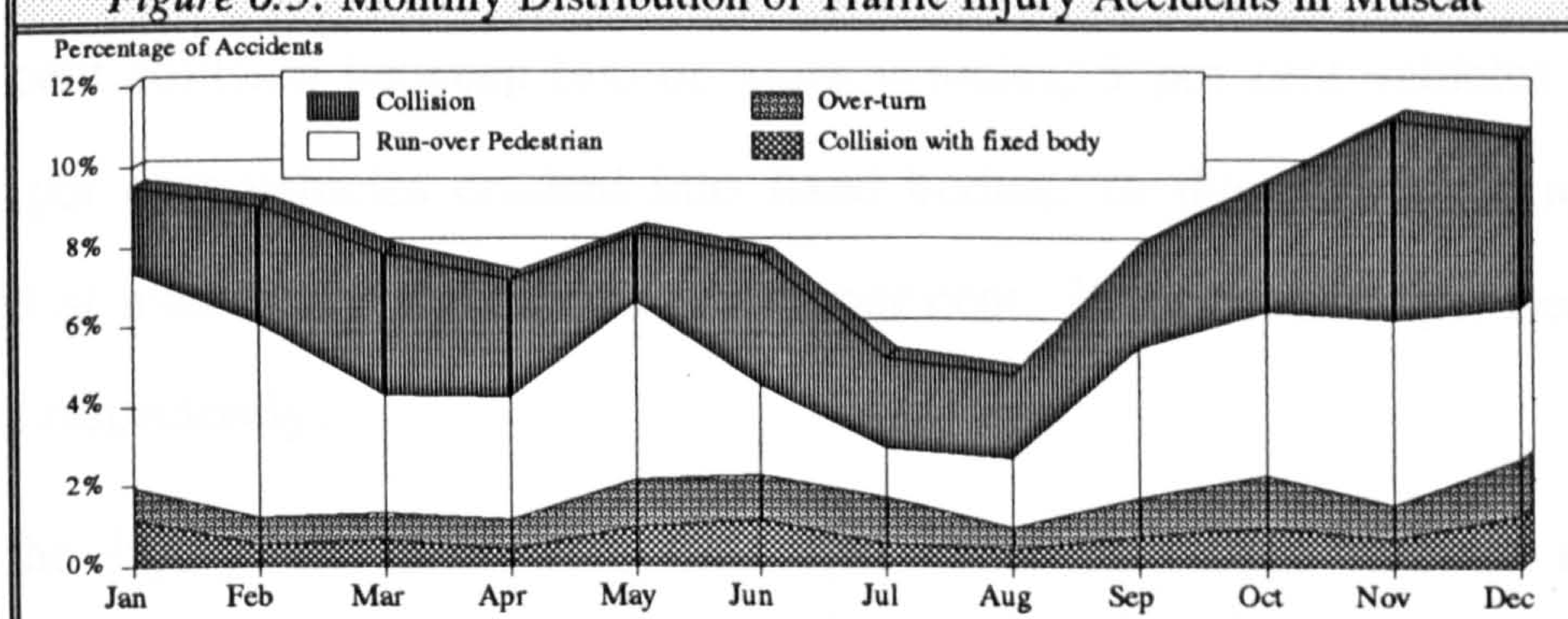



Source: Data collected from the Police Files, During the fieldwork trips in 1990 & 91

### 6.4.3.6 - MONTHLY DISTRIBUTION

The distribution of the 706 traffic injury accidents that occurred in the Muscat Area by month of the year 1990 indicate a range of 37 to 79 accidents per month. *Figure 6.5* shows the monthly variation of the injury accidents by type. A significant drop in July and August is noted because most people prefer to stay indoors due to the hot weather of the Muscat Area. Injury accidents build up from September to reach maximum peak in November and then start declining. This coincides with the opening of schools and the starting of the fine climate when outdoor activity increases. Accidents in which pedestrians are involved increases during this season.

*Figure 6.5*: Monthly Distribution of Traffic Injury Accidents in Muscat




Source: Data collected from the Police Files, During the fieldwork trips in 1990 & 91

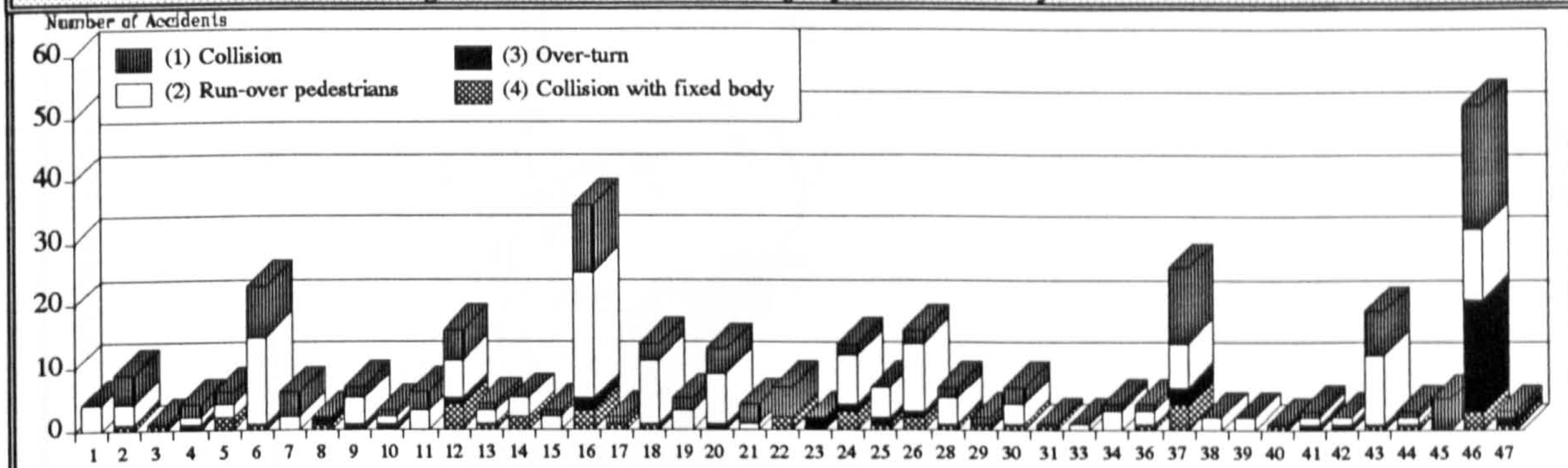
### 6.4.3.7 - GEOGRAPHICAL DISTRIBUTION OF INJURY ACCIDENTS

The lack of information to identify an exact location of the road accidents made it necessary to collect injury accident details in the Muscat Area from the police files with the intention of identifying high-risk sites in order to develop necessary solutions. In the absence of a grid reference map, it was anticipated that many police officers would have great difficulty in giving an accurate location of the accident. Therefore, an attempt was made only to identify the location of injury accident which occurred in the Muscat Area regional highways. The locations were identified in terms of intersections and road links of the east-west highway. In the case of Nizwa Road and Al-Hajar Road the accident locations were based on the whole section of the road within the Muscat Area boundary, reflecting the lack of clear land marks to which the accident can be related. *Figure 6.6* shows the codes of injury accidents locations.

Of the 706 injury accidents, 51.3 per cent of the injury accidents occurred within the designated sites for investigation in which the east-west corridor(Qaboos Road) accounted for 85 per cent, Al-Hajar Road for 14 per cent and Nizwa Road for only 1 per cent. When the injury accidents that occurred in the east-west corridor were examined in terms of the number accidents occurring at its links and intersections, it was found that 77.6 per cent of accidents occurred along the road links, while the intersections accounted only for 22.4 per cent. More than 51 per cent of the accidents occurring along the corridor links were between vehicles and pedestrians, 31 per cent collision between two or more vehicles, 5 per cent vehicles over-turn and 13 per cent vehicles crashed into fixed bodies. In the case of accidents that occurred at intersection the figures are 43 per cent, 37 per cent, 7 per cent and 13 per cent respectively.

When the injury accidents were examined in terms of the number of people involved, it was found that 52 per cent of all people involved in accidents in the Muscat Area were at the designated sites. Of the 52 per cent, 80 per cent were involved in accidents on the east-west corridor, 19 per cent on Al-Hajar Road and one per cent on Nizwa Road. Of the total people involved in accidents on the corridor, the corridor links accounted for 77 per cent, while the intersections for 23 per cent. (see *Figures 6.6, 6.7 and 6.8*)

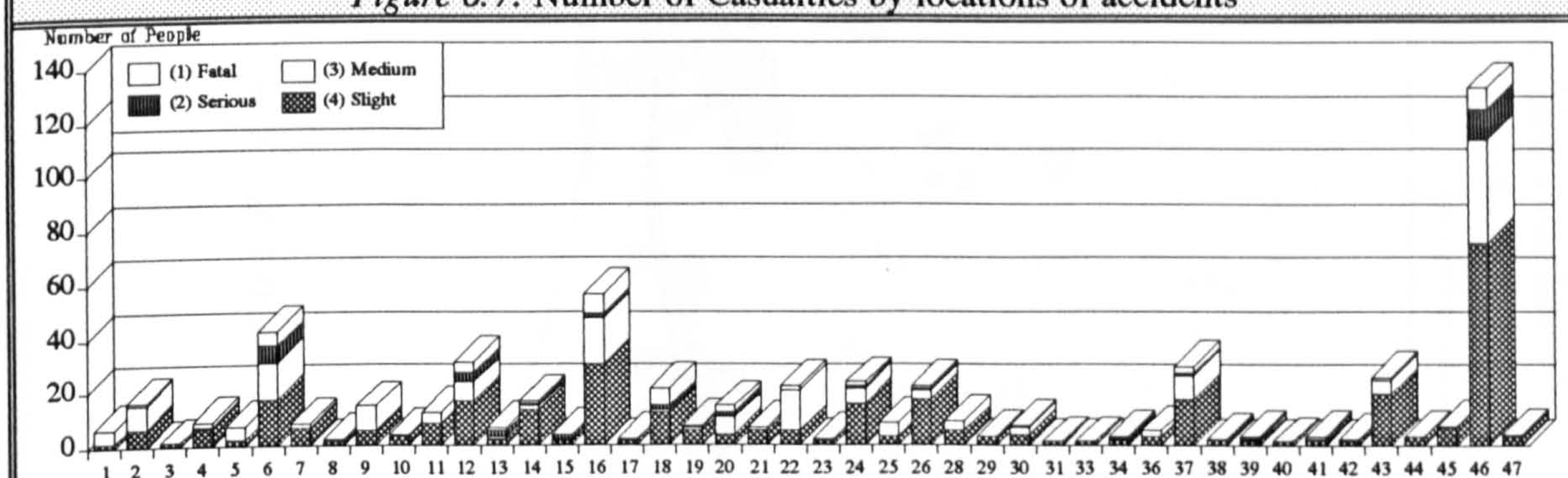
*Figure 6.6* : Number of Injury Accidents by Location




| Location | Type of Accidents 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 0 | 4 | 0 | 0 |
| 2 | 5 | 3 | 0 | 1 |
| 3 | 0 | 0 | 0 | 1 |
| 4 | 2 | 1 | 1 | 0 |
| 5 | 2 | 2 | 0 | 2 |
| 6 | 8 | 14 | 0 | 1 |
| 7 | 4 | 2 | 0 | 0 |
| 8 | 0 | 0 | 1 | 1 |
| 9 | 2 | 4 | 1 | 0 |
| 10 | 1 | 1 | 1 | 0 |
| 11 | 3 | 3 | 0 | 0 |
| 12 | 5 | 6 | 1 | 4 |
| 13 | 1 | 2 | 0 | 1 |
| 14 | 0 | 3 | 0 | 2 |
| 15 | 1 | 2 | 0 | 0 |
| 16 | 11 | 20 | 2 | 3 |
| 17 | 1 | 0 | 0 | 1 |
| 18 | 3 | 10 | 0 | 1 |
| 19 | 2 | 3 | 0 | 0 |
| 20 | 3 | 8 | 1 | 0 |
| 21 | 3 | 1 | 0 | 0 |
| 22 | 5 | 0 | 0 | 2 |
| 23 | 0 | 0 | 2 | 0 |
| 24 | 2 | 8 | 1 | 3 |
| 25 | 0 | 5 | 1 | 1 |
| 26 | 2 | 11 | 1 | 2 |
| 28 | 2 | 4 | 0 | 1 |
| 29 | 1 | 0 | 0 | 1 |
| 30 | 3 | 3 | 0 | 1 |
| 31 | 0 | 0 | 0 | 1 |
| 33 | 0 | 1 | 0 | 0 |
| 34 | 1 | 3 | 0 | 0 |
| 36 | 1 | 2 | 0 | 1 |
| 37 | 12 | 7 | 3 | 4 |
| 38 | 0 | 2 | 0 | 0 |
| 39 | 0 | 2 | 0 | 0 |
| 40 | 0 | 0 | 0 | 1 |
| 41 | 1 | 1 | 1 | 0 |
| 42 | 0 | 1 | 1 | 0 |
| 43 | 7 | 11 | 0 | 1 |
| 44 | 1 | 1 | 0 | 1 |
| 45 | 1 | 0 | 1 | 1 |
| 46 | 20 | 11 | 18 | 3 |
| 47 | 5 | 0 | 0 | 0 |

Source: Data collected from the Police Files, During the fieldwork trips in 1990 & 91

*Figure 6.7*: Number of Casualties by locations of accidents




| Location | Severity of Injury 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 0 | 0 | 5 | 1 |
| 2 | 1 | 0 | 9 | 6 |
| 3 | 0 | 0 | 0 | 1 |
| 4 | 2 | 0 | 1 | 6 |
| 5 | 0 | 0 | 5 | 2 |
| 6 | 5 | 6 | 14 | 17 |
| 7 | 0 | 0 | 2 | 6 |
| 8 | 1 | 0 | 0 | 1 |
| 9 | 0 | 0 | 9 | 5 |
| 10 | 0 | 0 | 1 | 3 |
| 11 | 0 | 0 | 4 | 8 |
| 12 | 4 | 4 | 7 | 16 |
| 13 | 1 | 2 | 1 | 2 |
| 14 | 1 | 1 | 1 | 13 |
| 15 | 0 | 2 | 1 | 1 |
| 16 | 7 | 2 | 17 | 30 |
| 17 | 0 | 0 | 1 | 1 |
| 18 | 7 | 1 | 1 | 12 |
| 19 | 0 | 1 | 1 | 5 |
| 20 | 2 | 2 | 6 | 4 |
| 21 | 0 | 0 | 1 | 5 |
| 22 | 2 | 0 | 15 | 5 |
| 23 | 0 | 0 | 1 | 1 |
| 24 | 1 | 1 | 6 | 15 |
| 25 | 0 | 0 | 5 | 3 |
| 26 | 1 | 1 | 3 | 17 |
| 28 | 0 | 0 | 4 | 5 |
| 29 | 0 | 0 | 0 | 3 |
| 30 | 0 | 1 | 2 | 4 |
| 31 | 0 | 0 | 0 | 1 |
| 33 | 0 | 0 | 0 | 1 |
| 34 | 0 | 1 | 0 | 2 |
| 36 | 0 | 0 | 2 | 3 |
| 37 | 2 | 1 | 9 | 17 |
| 38 | 0 | 0 | 0 | 2 |
| 39 | 0 | 1 | 1 | 1 |
| 40 | 0 | 0 | 0 | 1 |
| 41 | 0 | 0 | 1 | 2 |
| 42 | 0 | 0 | 1 | 1 |
| 43 | 1 | 0 | 5 | 19 |
| 44 | 0 | 0 | 0 | 3 |
| 45 | 0 | 0 | 1 | 3 |
| 46 | 8 | 12 | 38 | 75 |
| 47 | 0 | 0 | 1 | 6 |

Source: Data collected from the Police Files, During the fieldwork trips in 1990 & 91

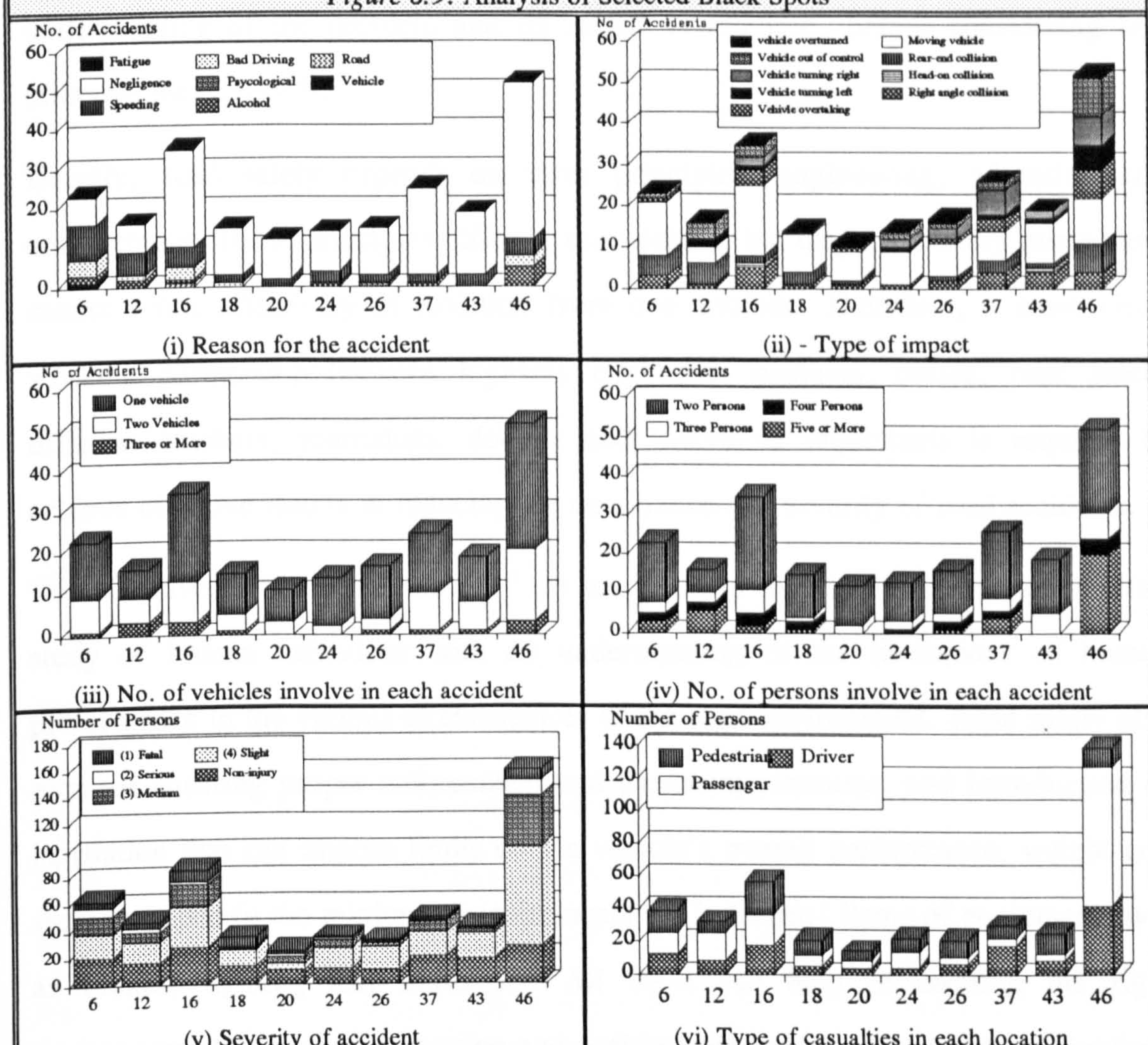

*Figure 6.8:* Accidents Locations

## 6.4.3.8 - BLACK SPOT LOCATIONS

A black spot can be defined as a limited area, usually a junction, where accidents are frequent during a certain period, say 8 accidents or more in a year(23). Black spots are also ranked according to a severity index or some measure of risk exposure, related to traffic volume. Black spots, ranked in order, are usually applied as a base for priority of investment so as to reduce accidents.

*Figure 6.9* illustrates diagrammatically further analysis for the highest ten black spots within the designated locations. These locations represent non-intersection locations and can vary from short lengths of about a half kilometre to relatively long lengths of several kilometres.

*Figure 6.9*: Analysis of Selected Black Spots




Source: Data collected from the Police Files, During the fieldwork trips in 1990 & 91

## 6.5: TRAFFIC ACCIDENT REDUCTION POLICIES

Road traffic accident reduction is an established part of all developed countries' transport policies, through there are serious problems with the usual methods employed in the fight against accidents(1). It is understandable that road safety is not singular in concept for which there is a simple remedy. There are many reasons for the growth in road accidents apart from the increase in population and wealth which enable more people a greater amount of individual travel. These reasons range from individual to collective apathy to man's physical and emotional limitations to safety in a mechanised environment. While many cities in the world have grown to their present size during the life of the motor vehicles, engineers and planners have failed to create an environment suitable for their safe and civilised use. A fuller understanding of the problem and its reason is required, before considering any effective measures(24).

Usually, road safety depends on three principles: engineering, education and enforcement. Those principles differ in their details, but they are closely related and cannot work effectively in isolation from one another. Therefore, a more close working partnership between highway engineers, planners, police, road safety officers, teachers, journalists, doctors and individual inhabitants is required to achieve effective results in reducing the occurrence and severity of road accidents.

The effective design and control of the road system by engineers demands a close study of human behaviour with an understanding of the limitations of human performance in the various circumstances of the road environment. Road safety also requires ensuring proper enforcement and treatment measures, and introduction of legislation that can impose limits on the vehicle's overall performance, weight and size, and specify the minimum requirements for individual items of equipment such as brakes, lighting and indicators. All these can help in creating the right environment for accident reduction and accident prevention. The following sections will review the main areas of road traffic accident reduction under the three main contributory factors - road user, vehicle and road environment. The degree of emphasis placed on the review of each factor varied and was determined by the results of road traffic accident analysis.

### 6.5.1 - THE ROAD USER

All road users have an important role to play in the prevention and reduction of accidents. While accidents are unlikely to arise from a single cause, the road user is of predominant influence. The statistics show that road users are wholly or partly responsible for more than 99 per cent of accidents and about 98 per cent of injury accidents. It is obvious, there is an enormous potential for accident reduction if the human failings can be eliminated. But this is very difficult to accomplish due to the fact that the human factor is the most complex and least understood element of any road problem. It is much easier to alter vehicles or roads than to change human nature. If, and when, roads and vehicles are made safer, then the failings of drivers, pedestrians and other road users, will assume even greater importance for the further reduction of accidents. A great many different human factors contribute to accidents, the main factors are(24):

1 - perceptual error, (e.g. driver or pedestrian looks but fails to see), distraction or lack of attention, misjudgement of speed or distance,

2 - lack of skill, (e.g. inexperience, lack of judgement, wrong action or decision)

3 - manner of execution, e.g. deficiency in action i.e. too fast, improper overtaking, failure to look, following too closely, wrong path), deficiency in behaviour(i.e. irresponsible or reckless, frustrated, aggressive),

4 - Impairment, (e.g. alcohol, fatigue, drugs, illness, emotional stress).

When considering remedial measures to reduce accidents, it must be borne in mind that the most effective remedy is not necessarily related directly to the main cause of the accident and may even lie in a different area of the road, vehicle or road user. This is particularly true of accidents in which the road user fails to cope with the road environment. In many accidents the primary cause may be the driver's lack of skill, but engineering remedies to improve the road are cheaper and easier to effect than training the driver to the necessary degree of skill(17).

6.5.1.1 - ROAD USER EDUCATION

Education broadly means informing all concerned with safety on the road what they need to know in order to fulfil their own responsibility and target audiences including the public, the highway engineers, the politicians, the judiciary and the police. Since the police are expected to have in their possession the knowledge of what causes accidents and congestion in order to take remedial action, they must ensure that they collect, analyse, respond to and disseminate accurate data. The police can then use every possible means to pass on this knowledge to those who can benefit from it. The collection of reliable data is fundamental to an accurate appreciation of the problem.

The aim of education programmes is to raise the level of awareness and skills of road users and assist in improving attitude and behaviour. Education programmes will be discussed according to their objectives: attitude-changing programmes and education and training programmes.

**Attitude-changing programmes**

Attitude change is usually the objective of a road safety campaign that employs mass communication techniques, including television, radio, roadside posters, the press, leaflets and exhibitions. It is also sometimes the objective of driver improvement programmes developed by traffic authorities for those who get involved in road accidents or traffic offences. Therefore, to ensure the effectiveness of such programmes they must be well defined and effectively presented.

Publicity programmes can complement traffic engineering measures aimed at accident reduction and can be designed to achieve specific objectives in terms of improved behaviour, knowledge or attitudes for specific target groups (e.g. child pedestrians, drivers, speed, etc.). Priority objectives and target groups can be determined by rigorous accident analysis. Ideally, this can be supplemented by collecting and analysis road user behaviour, knowledge and attitude data, reviewing past experience about the effectiveness of different campaigns (i.e. the extent to which they achieved their objectives) and carrying out small scale survey/ discussion group research to assess the likely impact and effectiveness of different potential campaign themes and approaches[25].

The Royal Oman Police, when possible, translate some of the available data into messages for the public through literature, school programmes, the press, television and broadcasting media. These methods appear to be employed effectively particularly during the Traffic Week which has been celebrated since 1985 in all countries of the Gulf Co-operation Council to help spread traffic awareness to the public. The significance of the Traffic Week is that all the agencies and ministries concerned co-operate in the publicity of traffic awareness. They try to make the public more aware of traffic accidents, their negative impact on society, their causes and how to avoid them. It is worth mentioning that each year the Traffic Week has a different theme, (e.g. in 1985 Pedestrians, 1986 Speed and 1990 Traffic Safety For Children).

It is clear that more effort needs to be made by the police and the concerned authorities in order to organise more publicity campaigns on many kinds of road safety aspects of national significance. There is convincing evidence in the United Kingdom that publicity campaigns directed at driver behaviour or other specific aspects of road safety have an initial beneficial effect but one that cannot be sustained on a long-term basis[1,25].

**Education and training programmes**

In most cases of road accidents in Oman, the driver was to blame[27], that is, driver error is considered the main factor in all traffic accidents. Hence, motor and informational skills must be acquired in order for a person to operate a vehicle safely on the road. This can be achieved by means of driver training and education programmes in which a background knowledge of road rules, physical laws, vehicle mechanics, and factual information about road safety may be combined together in order to maintain safe performance in driving. A similar road safety education and training programme can be developed for other road users, (e.g. the young, the elderly and cyclist).

Traffic accidents are one of the leading causes of death and injuries for youngsters under 15 years of age in Oman[28]. Therefore, the need for traffic safety education is very essential in order to produce safe road-user behaviour for life through a comprehensive continuous and developmental programme of education from the time children start school until the time they leave. Comprehensive programmes relating to all aspects of the safe use of the highway can be developed jointly by road safety officers, teachers and the police to provide a graduated process of instruction and learning, geared to the requirements, capabilities and ages of children concerned. The police consider involvement in the field of safety education for schools to be especially beneficial because it helps to develop closer liaison, co-operation and the exchange of information between the police and children.

### 6.5.1.2 - ROAD USER AND ENFORCEMENT

Drivers and pedestrians should not move haphazardly in the road. Their behaviour must be controlled by legislation and regulations showing how the road space is to be used (e.g. speed limits, direction signs, stop and give-way instruction). Whenever people walk across a road or drive through an intersection, some form of law should be there to tell them what to do and what not to do. Traffic laws are an integral part of the system, no less than on the road, the vehicle and the road user. Therefore, the traffic laws should be reasonable and enforceable, and they must be seen to be clearly understood and in the interest of the general public. The foreword of the Uniform Vehicle Code describes the purpose of all traffic legislation as:

> ... not to impose unnecessary and unreasonable restrictions on highway traffic, but to ensure, as far as this can be done by law and its application, that traffic shall move smoothly, expeditiously and safely; that no legitimate user of the highway, whether in a vehicle or on foot, shall be killed, injured or frustrated in such use by the improper behaviour of others[29].

Traffic legislation, regulation and control are meant to avoid traffic accidents if they are strictly enforced and obeyed. It is the responsibility of the police to enforce traffic ordinance in the course of dealing with traffic problems. Laws and regulations may carry little force in the absence of sufficient police resources to deter people from violating the law and to encourage them to comply voluntarily.

The Royal Oman Police Traffic Ordinance appears to provide a sound legislative base and it has the merit of being much simpler than the traffic law in the United Kingdom[26]. The effectiveness of the police is not easy to quantify except by historic accident data and the use of traffic data collection and detection equipment. However, in 1991, offences detected by the police amounted to 19,777 speeding cases, 3,390 cases of driving without a licence, 5,224 cases of not wearing a seat-belt, 857 cases of driving under the influence of alcohol and 33,202 other offences[15]. The police statistics did not include the types of other offences, and the distribution of these offences geographically and by time is not clear.

Without a comprehensive knowledge of the traffic ordinance in Oman any comments might be regarded as being out of place. Nevertheless the writer suggests that amendments to the traffic legislation and regulations might be considered if more detailed accident analysis proved the need for improvement. It is obvious the existence of a comprehensive data collection system would enable the police to indicate where, when, and what kind of traffic law enforcement may be most effective. In addition, the system will empower the police to make day-to-day decisions about allocating their resources available for checking speeding violations, careless and dangerous driving, and parking offences in order to achieve effective results.

However, the objective of police traffic law enforcement is to ensure that road users obey traffic laws. So enforcement action is the principal tool to reduce the number and severity of accidents, but it is probably impossible to prove that increasing enforcement by some amount will decrease accidents by the same amount. The approach to enforcement is as important as the viability of enforcement. Selective enforcement is recommended which targets specific high-accident areas and accident causing violations. Specific enforcement programmes focusing on violations producing accidents, can reduce the number of accidents resulting from these violations. This is particularly true when these specific programmes are accompanied by public information and education.

### 6.5.2 - *ROAD ENVIRONMENT*

The road factor is clearly important in influencing accident rates. In paragraph 2.4.2 of it's COBA9 Manual: the Department of Transport claims that "most of the reduction in accident rates which has occurred over the years may be attributed to road improvement and the transfer of traffic to safer types of road"[30]. It is estimated that 20 per cent of injury accidents could be avoided by low cost engineering methods, improving road lighting and particularly the safety of junctions[31]. As road environment deficiencies are usually associated with driver error, features can be grouped which show similarity in the difficulties presented to the driver, as follows:

1 - Adverse road design: derived mainly from accidents prior to which a driver did not appreciate a misleading visual situation, (e.g. unsuitable layout and junction design, poor visibility due to layout).

2 - Adverse environment: features which contribute to accidents by increasing the difficulty of manoeuvring a vehicle safely, (e.g. slippery road, flooded surface, lack of maintenance, weather condition).

3 - Obstructions: unexpected hazards,(e.g. roadwork, parked vehicle, animals).

4 - Inadequate road furniture or markings: insufficient and unclear information being represented to the driver, who is pre-occupied with manoeuvring his vehicle, (e.g. insufficient and/or unclear road signs and road markings, poor street lighting).

Oman and in particular the Muscat Area has very varied terrain in that the highway network traverses flat, rolling, mountainous land or runs along valleys. A small sector of the highway could contain several curves, slopes, hills, and flat alignment.

The physical nature of the highway requires a highly qualified, careful, and capable driver to control the vehicle. In addition, traffic volume and density, changing weather during the four seasons, and night driving are factors that highlight the role of the highway as a cause or direct factor of an accident.

The police statistics show that accidents caused by road environment account for less than one per cent of total accidents. These statistics do not provide any information to identify geographically the high-risk locations in order to suggest appropriate measures for these locations. On the other hand, information on injury accidents collected from the police files also do not identify precisely the high-risk locations of all injury accidents in the Muscat Area. In the absence of grid reference map, injury accident locations were identified in terms of road intersections and links, and limited to the regional highways. The indicated high-risk locations reveal that accidents that occurred in the road link sections were more than those which normally occur in the intersections, reflecting vehicles high speed and poor pedestrians facilities.

There are many engineering measures that aim at producing a safe physical road environment, but the time available for this study does not permit a detailed explanation or to suggest appropriate measures for the eradication of the located black spots separately. However, the design of roads, junctions, lighting, etc. will have an influence on accident levels if it is sub-standard or unsuited to the conditions in the vicinity of the accident site. Well-designed roads should allow greater margins of safety, enabling small errors of judgement, lack of concentration at a specific instant of time or a perception failure to be accommodated and, hence, avoid an accident by the provision of more space and time in design.

The relationship of road width, curvature and sight distance all have particularly marked effects on the occurrence of accidents. Hence, it is more sensible to consider these factors together as they have a psychological effect on the driver and influence his selection of running speed. The alignment of a road is also a major factor in determining how safely and efficiently the road will meet the traffic demands. The alignments are dependent on the topography, the nature of the traffic and the functional use of the road. Therefore, the general road alignment in such country as Oman must be selected carefully and must be compatible with traffic conditions by selecting appropriate horizontal and vertical curvature, and sight distances for the speed, vehicle types and traffic volumes in order to enable the driver to reach his destination safely.

A large proportion of injury accidents in the Muscat Area (44 % of total injury accidents) involves pedestrians, reflecting the lack of pedestrian facilities. This is not simply a matter of neglect, as other transport infrastructures and planning policies make walking very difficult or impossible, and so represent policies which are practised to eliminate walking as an important mode of transport. However, in spite of the real difficulties with the walking environment, walking as a mode of transport is very important in the Muscat Area, representing 21.5 per cent of all person trips (see Chapter 3). Therefore, providing sufficient pedestrian facilities must be given first priority to influence and restrict the occurrence of injury accidents.

Safe and comfortable walking is essential for pedestrian movement in a modern transportation system. To attain this goal, various measures can be introduced. The provision of facilities for pedestrians can take many forms all of which are ultimately bound up with good urban design, traffic restraint, and high-quality physical environment. Eliminating or reducing traffic significantly will lead to a great improvement in conditions for pedestrians and their safety. This is the basic idea behind pedestrian streets and pedestrian malls and areas, which should be considered in the case of Ruwi and Muttrah shopping areas. Providing a new or rearranged pedestrianized street (footpath), so that their users are completely separated from vehicular traffic, can be considered in the shopping and business areas and in the residential areas where pathways should be located so as to give convenient access from home to shops, schools, playground and other public facilities. At dangerous and congested locations such as schools or along footpaths on busy shopping streets, guard-rails can be used both to prevent pedestrians from slipping onto the carriageway and to channel the stream of pedestrian traffic towards formal pedestrian crossings.

The improvement of pedestrian movements and safety are no less important than other traffic flow. Therefore, pedestrians crossing the six-lane busy high-speed highways such as Qaboos highway can be restricted and limited to means of subway or bridges as pedestrian crossing facilities. This ideal type of crossing happens to be the most expensive, but cost effective considering traffic speed and volume on this vital highway and the number of people who have to cross it in spite of the difficulty and risk they have to take. Underpasses or overpasses can be provided where necessary and pedestrians can be restricted from crossing the highways by means of guard-rails.

Out of the major highways range, surface crossings can be provided to control and segregate pedestrian movements. The type of surface crossing required can be based on the availability of gaps in the traffic stream and the resultant delays likely to arise from road crossing by pedestrians. There are two main types of crossing: (i) uncontrolled crossing such as zebra crossing, where the right-of-way is automatically given to the pedestrian on the crossing, and (ii) controlled crossing, where the right-of-way is given to the pedestrian by the police or by traffic lights, (e.g. at traffic signals and pelican crossings). At the main pedestrian crossing points, road surfaces need careful selection (resistance to skidding), and the drivers can be presented with good visibility and guard-rails can be used where necessary to define routes and protect pedestrians.

Excessive speed is the single most widely blamed cause of accidents. In the Muscat Area it accounts for 21 per cent of all the injury accidents. A major consequence of increasing speed is that the total distance required to bring a vehicle to rest is considerably increased. It is obvious that the number and severity of accidents would be decreased if the speeds were restricted on streets and highways where the safety requirements make it desirable. Vehicle speed can be reduced by using various measures including speed limits, using a series of rumble bars across the carriageway and bar markings before roundabout intersections, humps and controlling road width in the residential streets, advisory speed signs. Street lighting is often a worthwhile investment helping to overcome the greater perception time required at night and thus improve road safety.

Many fatal accidents are the result of collisions with rigid obstacles. Therefore hazardous strong fixed objects located within the driving environment have to be removed or shielded. Errors in the human-vehicle-road system are often the cause of a vehicle running off the road. If the roadside is not safe, the consequence for such error is often severe injury or death. Medians and shoulders can be made safe in various ways: freedom from obstacles and sufficient width; collision-safe road side fittings; and protection of rigid obstacles. The latter can be provided by crash barriers and crash cushions[32].

The road network can be provided with sufficient traffic signs. Information essential to driving task and traffic signs including road markings, are an important means of advising, warning and controlling drivers and other road users. They must be effective in their environment, both on and off the highway, by day and night, presenting continuity, standardisation and reliability in prevailing traffic and weather conditions. The design and placement of signs must be considered in relation to their purpose and the performance capabilities of the road user in a specified situation.

Road traffic accidents may, with some accuracy, be described as a particularly noxious space-time event[12]. Therefore, it is necessary to have a comprehensive view of the problem in order to achieve accident prevention, encompassing land use planning and transport planning issues. It is not enough to focus on the vehicle or human agent or the immediate road environment as suitable cases for treatment. The increase in the length of the journey to work, shopping, hospitals and schools are the result of physical land planning. The increased distances, which have resulted from this process give considerable advantage to the car user, particularly in the absence of sufficient public transport, leading to high traffic volumes, hence to traffic accidents. Land use planning policy can ensure that amenity, safety and accessibility of facilities to all age ranges in the population are distributed in such way as to minimise the need to travel and to reduce vehicle and pedestrian conflicts, developing separated rights-of-way for the various activities and uses.

### 6.5.3 - *THE VEHICLE*

The vehicle factor contributes to less than one per cent of accidents in Oman. This figure is very low compared to 8.5 per cent in Britain(2). Therefore, as mentioned earlier, this low contribution of vehicle factor to traffic accidents could be either due to the high standard of safety requirements for vehicles in Oman or the lack of qualified investigators to identify clearly the true causes of the accident on-the-spot. However, the vehicle defects are due to inherent design limitations, a lack of regular maintenance, poor adjustment or failure of important components, such as tyres and brakes and lighting.

The vehicle has less variable characteristics and these features can be legislatively controlled within defined limits. Legislation can impose limits on the overall performance of vehicles, weight and size, and can specify the minimum requirements for individual items of equipment such as brakes, lighting and indicators in order to promote better vehicle safety.

## 6.6: CONCLUSION

Our need for transport relates to our civilised pattern of activities. The availability of the motor vehicle in the Muscat Area enhances accessibility and mobility and offers a wide choice of employment situations. At the same time it has consequences for the spatial location and activity patterns which result in considerable problems. Traffic congestion, noise, pollution, too many traffic accidents, and above all the demands for physical space and very costly infrastructures, all make it necessary to control the use of vehicles in Muscat Area.

Road traffic accidents and their human casualties have been a major scourge in Oman, particularly in Muscat Area. Road accidents are very serious and their reduction requires the efforts of different organisations and individuals. The seriousness of traffic accidents in Oman is illustrated by the high accident death rates compared with the rest of the world. The very high accident rates are expected to worsen, as the present factors are likely to persist, unless immediate improvement programmes are performed on a full scale and on the dangerous locations.

The solutions of the problems created by modern road transport depend on three elements - engineering, education and enforcement. A fuller realisation of the problems is required before considering any effective measures to create a safe and suitable civilised environment. The prevention of accidents and the promotion of free movement requires good design and control of the road system, a close study of human behaviour and movements, well-maintained vehicles, an acceptable set of rules to be obeyed and, most importantly, a high degree of discipline by drivers and other road users.

## 6.7: RECOMMENDATIONS

> The arguments for aiding and abetting the growth of car ownership are morally and politically seductive, but they lead to a dirty, dangerous, socially polarised, fume-filled greenhouse[33].

There is no simple remedy for the problems created by motor vehicles. It is completely out of date to solve urban transport problems by huge investments in complex highways. It is important that the emphasis move a way from the predominance of road investment. Capital expenditure in transportation can be revised to relate more to need and benefit, and treated by the government on a longer term basis. The government policy can include the relative merits of traffic management, public transport operation and investment, and the demand management of road use with the emphasis on the interrelationship of transportation with land use and development density.

Road traffic congestion is spreading in the Muscat Area and with the forecast traffic increase, it will become worse unless effective measures are taken to reduce it. There is of course congestion on the roads of many cities and towns for many years but the exercise of considerable ingenuity in traffic management together with various road improvements and bypasses has prevented it from becoming intolerable and in some cases it has actually improved. However, the scope for further traffic management progress is becoming progressively less, especially in view of the tendency for discernible traffic flow to attract additional cars on to the roads. In many urban areas major new road building is no longer practicable except at unacceptable levels of financial and environmental cost(4).

With the rapid use of the motor vehicle coupled with the growing demand for road space and high costs of expanding capacity, it is probably only a matter of a short time before the need for some form of motor vehicle restraint arises as part of a broad program to combat worsening transport conditions in the Muscat Area. There are several methods that can be employed to reduce excessive demand for road use. The methods range from road pricing and area licensing to fuel tax and land use control. The advantage of these demand management measures is that they require little initial capital outlay. The disadvantage is the inevitable opposition of the public to these measures, in particular the payment for use of city streets. Nonetheless, with careful preparation and planning transport demand management can be one of the most cost-effective means of dealing with urban transport problems(34).

However, in view of the culture of the country, the suitability of certain demand management measures require careful examination to ensure that the proposed options will fit properly with the social, economic, and topographical conditions.

These measures may be more effective and easily accepted if they are coupled with general improvements in traffic flow and public transport, thus benefiting the majority of road users. The latter would also need to be characterised by quality of service rather than the quality of profit. The following measures are selected as a useful frame of reference for decisions on urban transport problem in the Muscat Area:

- Land use controls to influence the magnitude and type of transport demand by controlling locations of employment opportunities, residential areas and the density of land use occupation. The aim is to reduce number of trips, particularly work trips, and to create the right environment for adequate public transport.
- Parking controls to prevent long-term parking in certain areas by commuters while allowing normal business and commercial activities such as those in Singapore.
- User taxes on fuel, spare parts and the like to restrain the use of vehicles in general by increasing the cost of travel as a function of use or distance regardless to where and when a vehicle is used, as in the Republic of Korea.
- Financial restraints on vehicle ownership, such us high import duties, sales taxes, or annual licensing fees, as in Egypt. This kind of restraint also does not influence the location and time of car use. Moreover, it will encourage vehicle owners to keep their cars longer. Older cars may be less safe and break down more frequently, thereby adding to congestion.

These measures are likely to be unpopular with motorists, but if authorities can select measures best suited to the condition of their city in conjunction with general improvements in traffic flow and public transport, it should benefit the majority of road users and eventually gain acceptance. The World Bank (1986) emphasises the application of demand management measures, saying:

> Although it may become more and more necessary to restrain excessive road use, demand management cannot provide the total solution to congestion. Many journeys, particularly those of public transport vehicles and goods vehicles, make a vital contribution to the development of the city, and there growing demand for road space must be met. Thus, even with effective demand management, most cities will be faced with large investments to increase the capacity of their transport system. A very cost-effective means of accomplishing this is the use of comprehensive traffic management measures(34).

Therefore the concerned authorities in the Muscat Area can consider the use of comprehensive traffic management measures to overcome the worsening transport conditions. The demand management measures can form a part of a comprehensive traffic management scheme including improvement of public transport, parking facilities, traffic movement and control, road safety, transport planning, and so forth.

The appropriate recommendations for improving road safety depend on the overall traffic condition in the Muscat Area. Therefore, it is important to consider all aspects of the transportation system in order to encourage reduction and prevention of traffic accidents. The following suggestions may help in achieving sufficient road safety:

1) - Developing of National Ambulance Service System, providing means of communication facilities on the highways, organising first aid education programs to increase the public awareness, and establishing a Highway Patrol Unit that can provide quick attendance to the accident and provide means of alternative rescue service in the absence of ambulance and rescue teams.

2) - Development of a comprehensive data collection system that can fit within the available funds. ensuring accurate, complete, and compatible data by providing the necessary means of recording, storing, analysing and presenting data considering that the information may be required by a variety of different people for a variety of purposes.

3) - Improvement of the competence of young drivers of motor vehicles by improvements in training and requirements for theoretical and practical tests. The quality of driving instructors and the driving test itself can be improved in consideration of the road user characteristics.

4) - Organisation of more publicity campaigns about various kinds of road safety aspects intermittently to raise the level of awareness and skills of road users. Publicity programmes should be designed to achieve specific objectives and the priority in targeting specific group can be determined by rigorous accident analysis.

5) - Driver training and education programmes can include a background knowledge of road rules, physical laws, vehicle mechanics, and factual information about road safety all combined together to maintain safe performance in driving. In addition, there can also be road safety surveillance as a way of improving the education of road users.

6) - Improvement of traffic safety for children. This involves promoting a programme of instruction and directing attention of parents to the necessity of their involvement in this kind of training. It is very essential to develop an education programme relating to all aspects of the road safety to produce safe road user behaviour for life through a continuous and developmental programme of education from the time children start school until the time they leave.

7) - Development of traffic rules to ensure that traffic moves smoothly, expeditiously and safely. These rules should be reasonable, clearly understood and in the interest of the general public. There should also be sufficient police resources, including data collection and detection equipment, to deter people from violating the law and to encourage them to comply voluntarily.

8) - The design of highways should allow greater margins of safety, enabling small errors of judgement, lack of concentration at a specific instant of time or a perception failure to be accommodated and their alignment selected carefully in such a way as to be compatible with traffic conditions. Any hazardous strong fixed objects located within the driving environment can be removed or shielded. The road network can be provided with sufficient traffic signs that are effective in their environment, and their design and position must be considered in relation to their purpose and the performance capabilities of the road user in a specified situation.

9) - Providing sufficient pedestrian facilities must be the first priority to achieve effective results in influencing and restricting the occurrence of injury accidents. These can be in form of pedestrian streets, surface crossings to control and segregate pedestrian movements. Underpasses or overpasses along the highways and pedestrians can be restricted from crossing by means of guard-rails. At the crossing points, road surfaces need careful selection. The drivers can be presented with good visibility and guard-rails can be used where necessary to define routes and protect pedestrians.

10) - Land use planning policy can ensure that amenity, safety and accessibility of facilities to all age ranges in the population are distributed in such way as to minimise the need to travel and to reduce vehicle and pedestrian conflicts. Developing separated rights-of-way for the various activities and uses.

11) - Improvement of vehicle safety including attention to brakes, lighting, helmets, tyres, bumpers, and the adoption of a rigid and standard form of vehicle testing. Specifying the minimum requirements for vehicle design measures that can make the consequences of accidents involving pedestrian and riders of two-wheeled vehicles less severe.

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# CHAPTER 7
## *PARKING DEMAND AND PROBLEMS*

### 7.0 - INTRODUCTION

Parking facilities are an integral part of the transport system. Traffic is not usually generated for the sake of movement. It travels towards a destination and, having arrived there, the vehicle must be parked whilst some business, whether private, public, recreation, or service, is transacted. Failure to supply sufficient parking facilities can result in congestion and frustration(1). This, in turn, may lead people to travel to better served areas and hence a decline in the importance of poorly serviced ones. Parking, in particular, is such a sensitive issue that commercial interests are directly affected by the parking situation. Many retailers and business people in the city centres tend to regard parked kerbs as necessary visual evidence of trade prosperity(2).

The purpose of this Chapter is to assess the parking characteristics and facilities, especially around the major shopping and business areas. Measurements such as parking accumulation, volume, turnover and duration are used to assess the parking characteristics of vehicles, such as where they are parked and for how long, the effect of trip purpose and walking distance on parking duration. These measurements would help to determine the facts that can clarify the problem and indicate a solution. For example, parking policy in which both the parking space available and duration of use of those spaces can be controlled in view of long term effects on the economic viability of the areas in question. The assessment is based mainly on a survey carried out in selected locations in Greater Muttrah in 1990 (see appendix D).

### 7.1 - THE NEED FOR A PARKING POLICY

In any urban environment with a rapid rise in the degree of motorisation and use, the issues related to parking constitute an increasingly serious problem. No series of proposals aimed at improving the traffic flow in an urban road system can ignore the problem of parking. Policies which are adopted to control parking will not only have a substantial effect on the traffic flow of an area but they will also affect pedestrian movement and the economic activity in the area. Parking requirements develop wherever people congregate and consequently parking becomes a major land use which will increase in intensity. Extensive off-street parking should be provided at industrial estates, office and commercial areas, high density residential districts, retail centres, universities, airports, stadiums and at change-of-travel-mode points within transportation systems.

The sharp increase in the number of privately owned vehicles coupled with the growing tendency to use personal means of transport lead to major parking problems in the Muscat Area, especially around the commercial and government administration areas. In the face of this growing demand for parking spaces, the available spaces at the present time are quite primitive. The on-street parking spaces are very limited and most of the currently used off-street ones are on private lots which are awaiting development, thus making the problem even worse in the absence of an immediate solution.

There is a need to introduce a parking policy in conjunction with reserving and acquiring suitable sites for car parking purposes as close as possible to the major shopping and business areas. Unless parking facilities are provided and controlled, people may be discouraged from travelling to these areas which, in turn, may affect the importance of their economy and therefore their land values may tend to fall. This is the case in Muttrah High Street. Weidleplan Consultants (1990) says:

> In Muttrah High Street, the lack of parking becomes so acute that some businesses have already moved to readily accessible locations. The situation is also beginning to effect traders in Muttrah shopping itself(3).

It is completely out of date and inadequate to rely on using undeveloped sites or lots which are awaiting development for parking purposes. Adequate, planned and controlled car parking is essential to the life of the commercial and business areas in the Muscat Area. Therefore, thought and consideration should be given to the type and size of these activities in planning, siting and operation of parking spaces. The improvement of parking provision can relieve traffic congestion and related problems. Therefore, the provision and siting of car parks should be related to the capacity of roads that carry the traffic to the concerned area. The wise siting of car parks can make it possible to increase the number of vehicles that can be parked in the urban area, without causing congestion and traffic accidents.

It is widely acknowledged that the supply of facilities for private cars in a central areas has to be limited and controlled in order to maintain the desired accessibility and environmental quality[(4)]. Various restraint measures are in use, ranging from limiting the capacity of roads (bus lanes, signal control) to parking restrictions such as limiting car park capacity and imposing a parking fee and time limits to ensure that a continuous parking space is made available for visitors.

However, widespread use of traffic restraint measures in urban areas does not always reflect a sound planning policy. What is needed is parking policy options that can provide a balance between local demand and the capacity of the road network that can fit with the cultural, topographical and socio-economic conditions of the Muscat Area. Decisions therefore must be made to determine the aims of a parking policy; that is, to determine which part of the demand should be met. This parking study provides an indication of the magnitude of likely parking demand in the problematic areas and may therefore be used as the starting point for developing soundly based parking policies.

## 7.2 - PARKING DEMAND AND PROBLEMS

Parking problems in old parts of the Muscat Area were recognised in the early '70s as the result of an increase of private vehicle ownership and cars use in urban environment patterns related to non-motorised modes of transport. The previous transport studies and other related studies had already recognised the problems of parking and suggested some policies for adoption in the problematic areas, but there were few means of solving the problems. The parking problems in the previous studies are seen as an exclusively technical issue which needs to be addressed and studied separately and in detail. The studies were satisfied with representing the problems in the form of a literature review without any assessment based on a parking survey. In only one study(5) parking duration and accumulation surveys were carried out in Muttrah Suq and in Ruwi and Muttrah High Streets. In fact, this study itself admitted that these surveys were unable to provide an estimate for parking demand in these areas. Therefore, the parking problem deserves a detailed study in consideration to the overall condition of the transportation system.

Naturally, the question arises as to the predominant factors causing a severe parking problem in the developing area of Muscat. The topographical nature of Muscat is an important limiting factor in the availability of the parking spaces. The topographical nature of the area limits the flat land available for housing, shops, schools, and other elements of the infrastructure. Due to competition for space, insufficient land is allocated for car parking in the major activity centres, and the result is an acute shortage of parking spaces in these areas. On nearly every day of the week motorists in search of a parking space can be observed driving around in the streets in Ruwi and Muttrah in the hope of finding a vacant space near their destination, leading to unnecessary traffic(3).

> Insufficient land has been allocated for off-street car parking in the commercial areas of Muttrah, Muscat and Ruwi, with the result that streets in these areas are prone to traffic congestion(6).

In undefined on-street parking spaces in most parts of the Muscat Area, especially in the densely developed parts of Greater Muttrah, motorists simply drive off the road and park their vehicles anywhere along the road. Apart from posing a serious safety hazard to moving traffic and pedestrians, such a method of parking reduces the road space available to moving vehicles, thus minimising road capacity, which often leads to traffic congestion. The absence of regulations for the use of parking spaces makes the problem worse. Motorists can leave their vehicles for as long as they wish.

> The amount of land explicitly laid out for parking at the present is small relative to the overall demand. As a consequence, parking tends to be haphazard, uncontrolled, and is difficult to quantify with any certainty(7).

The change of land use from residential to commercial and the invariable mix-up, and the increasing number of multi-story buildings around the commercial areas, particularly in Ruwi without providing car parks within the legal boundaries of the lots, create considerable pressure on the parking places and traffic movement. The recent development of the city network to cater for the increase in traffic volume, which resulted from high car ownership and expanding population, was not accompanied by further extension of car parking facilities.

> Most of the parking facilities are related and belong to commercial and administrative centres. Public parking in urban areas is rare and in business areas(e.g. Ruwi High Street) diverted into backside roads where cars are parked on or off-street (unorganised parking) and lead thus to problems in these areas(8).

The weather plays a significant role in further exacerbating the situation. The very high temperature in the summer, for instance, makes people park as close as possible to their destination to avoid the heat. This kind of parking results in the disorganised accumulation of vehicles which effects the streets capacity, and creates congestion and delay in the traffic flow.

The concentration of commercial activities is in the old high density built-up areas of Ruwi and Muttrah where the streets are narrow and limited, and car parking provision is unable to meet traffic demand generated from new developments. Houses in these areas have no garages, and due to the lack of off-street parking, residents have to park their cars on both sides of the streets and hence create obstruction for pedestrians and traffic flow, resulting in congestion, delay and traffic accidents.

## 7.3 - AVAILABILITY OF PARKING SPACES

People in the Muscat Area go largely where and when they wish; most frequently where travel facilities best meet their needs and convenience. Drivers usually assume that they can park their vehicles within a reasonable distance from their final destination, sometimes accepting that, in congested areas, this might involve some time searching for a space. Drivers' personal judgements of what constitutes an acceptable place to park vary considerably in terms of location and size of space. Such judgements are influenced by the purpose and urgency of the trips, and individual attitudes and behaviour patterns(9).

The availability of parking spaces in a particular area increases its attractiveness to drivers. In order to explore the availability of parking spaces in each municipality by type of parking available, vehicle drivers were requested to indicate the type and degree of difficulty in finding the parking space. *Table 7.1* shows the availability of parking spaces for each type of parking as found from the Home Interview Survey. Vacant land is the most common parking type; 32 per cent of all vehicles use this type of parking. Paved private parks make up 22 per cent of all parked vehicles, paved public parks account for 20 per cent, paved roadside 11 per cent and unpaved roadside 15 per cent of all available parking spaces.

This high percentage of parking in undeveloped sites and lots, may worsen the problem of parking in the future in the absence of an immediate solution. Vacant land accommodates 32 per cent of all parked vehicles in Greater Muttrah, 25 per cent in Boashar, 40 per cent in Seeb and 43 per cent in Al-Amarat, reflecting the type of land use and development density in these municipalities (Chapter 2).

At present, finding a space in the Muscat Area involves little difficulty in the case of overall parking condition despite trip purpose and destination area. However, there is great variation in terms of the difficulty between finding a parking space in residential and commercial areas within each municipality or from one municipality to another (difficult in the areas of highest demand such as shopping and business districts). For many journeys, finding a parking space in Muttrah involves more difficulty than in other municipalities, particularly, in the case of paved roadside car parks where 56 per cent of the drivers indicated that it is difficult and 30 per cent said it is fairly easy. Finding a paved private parking space is easier (80 - 91% easy) than other types of parking in all the municipalities, followed by vacant land ( 72 - 92% easy).

*Table 7.2* shows the availability of parking spaces for each type of parking as found from the Roadside Interview Survey. Paved public car parks is the most common parking type for the trips that end within the Muscat Area; 39 per cent of all vehicles use this type of parking. Vacant land makes up 22 per cent of all parked vehicles, paved private car parks account for 20 per cent, paved roadside 9 per cent and unpaved roadside 12 per cent of all available parking spaces. This slight variation between the two surveys in terms of type of parking used could be explained by trip destination purposes, where in the Roadside Interview work trips have the highest proportion of all trips that end within the Muscat Area (30% of all external trips, see Chapter 3).

When the type of parking is seen in terms of the difficulty of finding parking spaces, the finding of the Roadside Interview coincide with those of the Home Interview and confirm the degree of difficulty in finding a parking space for each type of parking in Muscat Area or at municipal levels.

## 7.4 - PARKING DURATION

It is important, when planning a parking scheme, to know the length of time that vehicles are parked so that plans can be made for long and short term parking. The distribution of parking duration in the Muscat Area by basic purposes is shown in *figures 7.1 and 7.2*. As expected, the average parking duration of parked vehicles for non-work purposes is shorter than for work purpose.

*Table 7.1:* **Availability of Parking Spaces in Muscat Area** (Home Interview Survey)

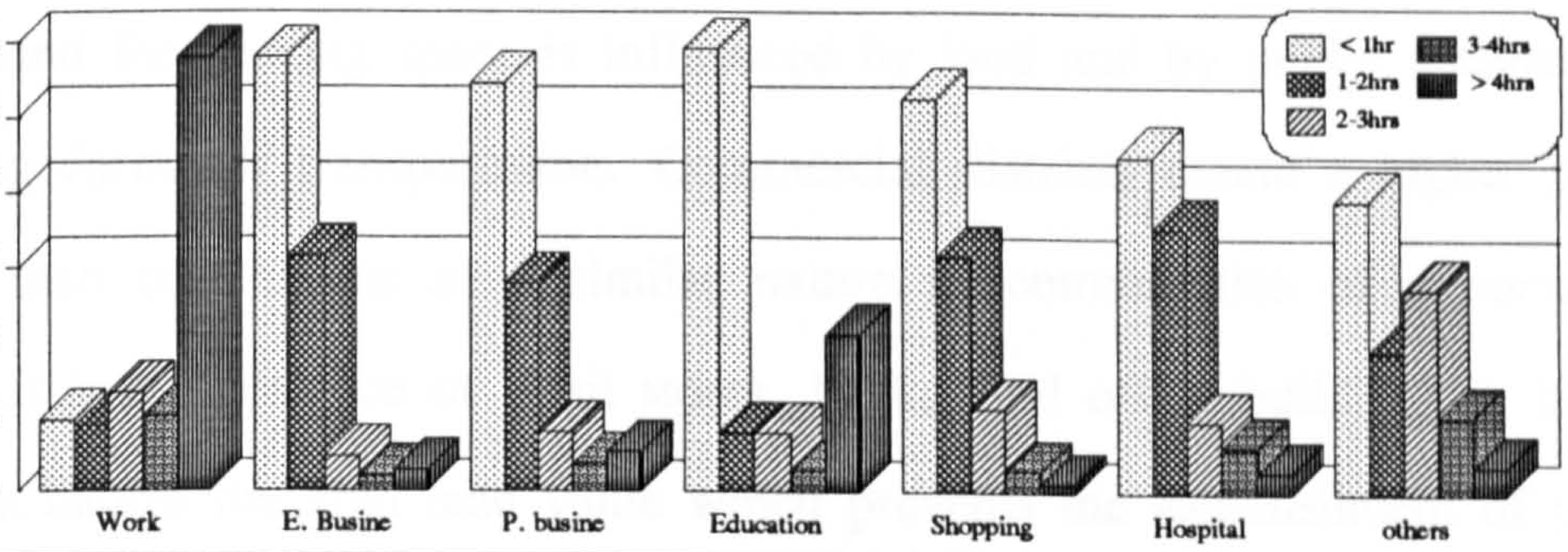
| Code | Municipality | Paved Private Park | | | Paved Public Park | | | Vacant Land | | | Paved Roadside | | | Unpaved Roadside | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | |
| 1 | **Greater Muttrah** | 140 | 27 | 7 | 47 | 62 | 54 | 219 | 63 | 23 | 25 | 51 | 96 | 48 | 44 | 37 | 943 |
| Percentage in Each | | 80% | 16% | 4% | 29% | 38% | 33% | 72% | 21% | 7% | 14% | 30% | 56% | 37% | 34% | 29% | 45% |
| Percentage Per Type | | < ---- 19% ---- > | | | < ---- 17% ---- > | | | < ---- 32% ---- > | | | < ---- 18% ---- > | | | < ---- 14% ---- > | | | 100% |
| 2 | **Basher** | 164 | 38 | 10 | 114 | 78 | 14 | 173 | 12 | 6 | 21 | 11 | 7 | 99 | 17 | 3 | 767 |
| Percentage in Each | | 77% | 18% | 5% | 55% | 38% | 7% | 91% | 6% | 3% | 54% | 28% | 18% | 83% | 16% | 1% | 36% |
| Percentage Per Type | | < ---- 28% ---- > | | | < ---- 27% ---- > | | | < ---- 25% ---- > | | | < ---- 5% ---- > | | | < ---- 15% --- > | | | 100% |
| 3 | **Seeb** | 67 | 6 | 1 | 36 | 15 | 3 | 128 | 10 | 1 | 6 | 3 | 2 | 56 | 16 | 1 | 351 |
| Percentage in Each | | 91% | 8% | 1% | 67% | 28% | 5% | 92% | 7% | 1% | 55% | 27% | 18% | 77% | 22% | 1% | 17% |
| Percentage Per Type | | < ---- 21% ---- > | | | < ---- 15% ---- > | | | < ---- 40% ---- > | | | < ---- 3% ---- > | | | < ---- 21% ---- > | | | 100% |
| | **Muscat Area** | 373 | 71 | 18 | 199 | 155 | 71 | 563 | 85 | 30 | 52 | 65 | 105 | 207 | 77 | 41 | 2112 |
| Percentage in Each | | 81% | 15% | 4% | 47% | 36% | 17% | 83% | 13% | 4% | 23% | 29% | 48% | 64% | 24% | 12% | 100% |
| Percentage Per Type | | < ---- 22% ---- > | | | < ---- 20% ---- > | | | < ---- 32% ---- > | | | < ---- 11% ---- > | | | < ---- 15% ---- > | | | 100% |

*Table 7.2:* **Availability of Parking Spaces in Muscat Area** (Roadside Interview Survey)

| Code | Municipality | Paved Private Park | | | Paved Public Park | | | Vacant Land | | | Paved Roadside | | | Unpaved Roadside | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | |
| 1 | **Greater Muttrah** | 14 | 5 | 3 | 27 | 38 | 23 | 10 | 6 | 4 | 5 | 19 | 22 | 3 | 9 | 5 | 193 |
| Percentage in Each | | 64% | 23% | 13% | 31% | 43% | 26% | 50% | 30% | 20% | 11% | 41% | 48% | 18% | 53% | 29% | 30% |
| Percentage Per Type | | < ---- 11% ---- > | | | < ---- 46% ---- > | | | < ---- 10% ---- > | | | < ---- 24% ---- > | | | < ---- 17% ---- > | | | 100% |
| 2 | **Boashar** | 31 | 5 | 2 | 40 | 38 | 10 | 30 | 3 | 1 | 5 | 2 | 1 | 7 | 7 | 1 | 183 |
| Percentage in Each | | 82% | 13% | 5% | 45% | 43% | 12% | 88% | 9% | 3% | 62% | 25% | 13% | 47% | 47% | 6% | 28% |
| Percentage Per Type | | < ---- 21% ---- > | | | < ---- 48% ---- > | | | < ---- 19% ---- > | | | < ---- 4% ---- > | | | < ---- 8% --- > | | | 100% |
| 3 | **Seeb** | 45 | 7 | 2 | 43 | 26 | 10 | 75 | 9 | 1 | 3 | 2 | 0 | 33 | 11 | 1 | 268 |
| Percentage in Each | | 83% | 13% | 4% | 54% | 33% | 13% | 88% | 11% | 1% | 60% | 40% | 0% | 73% | 24% | 3% | 42% |
| Percentage Per Type | | < ---- 20% ---- > | | | < ---- 29% ---- > | | | < ---- 32% ---- > | | | < ---- 2% ---- > | | | < ---- 17% ---- > | | | 100% |
| | **Muscat Area** | 90 | 17 | 7 | 110 | 102 | 43 | 115 | 18 | 6 | 13 | 23 | 23 | 43 | 27 | 7 | 644 |
| Percentage in Each | | 79% | 15% | 6% | 43% | 40% | 17% | 83% | 13% | 4% | 22% | 39% | 39% | 56% | 35% | 9% | 100% |
| Percentage Per Type | | < ---- 18% ---- > | | | < ---- 39% ---- > | | | < ---- 22% ---- > | | | < ---- 9% ---- > | | | < ---- 12% ---- > | | | 100% |

Source: Roadside Interview Survey, Fieldwork Muscat 1990

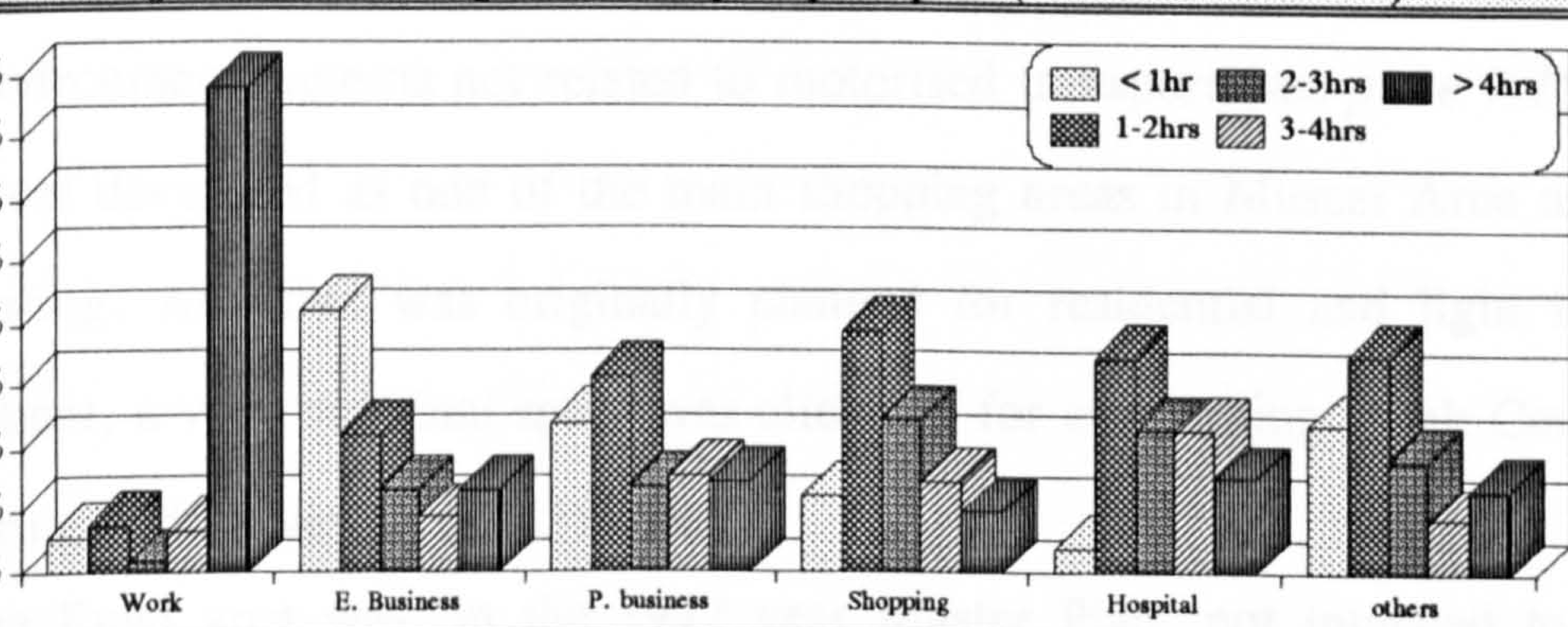
*Figure 7.1*: Parking Duration by Trip Purpose (Home Interview)




Source: Home Interview, Fieldwork Muscat 1990

A high proportion of parked vehicles at all other destination purposes other than work do park for periods of less than one hour, followed by a duration period of 1 to 2 hours time band. About 68 per cent of vehicles parked for work purposes are for more than 4 hours. In the case of trips generated from areas outside Muscat Area, a high proportion of vehicles parked for purposes other than work do park for periods between 1 to 2 hours, followed by periods of less than one hour. The average parking duration of vehicles reported in the Home Interview is less than those reported in the Roadside Interview carried out for this study. The increased duration of parking for work in the Roadside Interview is probably due to the tendency to park all day rather than to leave the car park for other purposes as in the case of the resident of the Muscat Area.

*Figure 7.2* : Parking Duration by Trip Purpose (Roadside Interview)




Source: Roadside Interview, Fieldwork Muscat 1990

## 7.5 - PARKING DEMAND IN THE SHOPPING AND BUSINESS AREAS

The demand for parking space is influenced by land and by public acceptance of competing forms of transportation. Commercial districts create a higher parking demand than other areas of a similar nature in communities of a comparable size(10). It is the presence of retail stores, banks, and office buildings in the core areas that causes the high land value which prevents the establishment of parking facilities, and at the same time generates the demand for them(11).

The Weidleplan Consultant(25) indicates that due to Muttrah municipality's role as a major centre the commercial land use will increase. However, due to the already congested situation, this growth will generally take place in mixed residential/ commercial land use (change of land use from residential to commercial in the form of multi-storey buildings). At present, Greater Muttrah accounts for the majority of personal movements (Chapter 3), and with such a development strategy, more trips will be attracted to Muttrah, hence there will be a need for more parking facilities.

Most of the retailing activities in Greater Muttrah are concentrated in old Muttrah Suq and around Ruwi High Street, while other commercial activities are concentrated in the Central Business District in Ruwi. Muttrah Suq represents the traditional pattern of a shopping area, where a large number of small shops are closely grouped, and with narrow walkways for pedestrian access in high density urban environment patterns not related to motorised transport (see *plate 7.1*). Ruwi High Street developed as one of the main shopping areas in Muscat Area and it is still growing. As Ruwi was originally planned for residential and light industry development, a very marginal space was allocated for car parking. Viak Consulting Engineering and Surveyors (1983) write:

> The Ruwi area was, in the 1972 year Master Plan, not intended to be commercial area, but developed as residential and light industrial area only. Hence the road network and the parking spaces have not been planned and can not cope with the huge number of people and vehicles presently attracted by the area. It seems likely that this attraction will not be reduced in future(12).

The commercial activities in the Central Business District in Ruwi include large retail stores and other business and commercial activities. It is located in the east of Ruwi High Street and planned in 1974 to be the big business, commercial and entertainment centre of Greater Muttrah and Oman(13). Off-street and on-street car parking spaces are provided and distributed in a way that all parts of the area are easily accessible, but the traffic increase and the parking demand are much higher than that foreseen in 1974.

Parking problems in commercial areas have been indicated in most of the previous transport and related studies, but there are few means of solving them. In the case of Ruwi commercial areas, Llewelyn-Davies in the South Ruwi/Hamriya Improvement Plan (1983) commented:

> Parking is a major problem particularly in the commercial areas of West and East Ruwi. With the provision of kerbs, footpaths and formalised parking the number of on-street spaces is likely to halve(14).

In order to meet the parking demand Llewelyn-Davies suggested providing off-street parking areas including six major car parks capable of becoming multi-storey. To avoid untenable public costs, it was suggested that on-plot parking standards must be enforced, preferably basement parking for residents with some at grade provision for visitors. Because the road areas and the parking spaces within Ruwi commercial area are insufficient, a proposal has been raised to close Ruwi High Street for vehicular traffic and reinstate it as a shopping area for pedestrians only. For this purpose, a study(12) was carried out to provide the necessary facilities including off-street parking spaces. In the Muttrah Plan Review (1982),(15) four multi-storey car parks with 1.400 spaces in old Muttrah Suq are proposed. Long term solution for Muttrah's commercial areas was seen in a parking policy that discriminates against all-day parking in favour of short stay visitors by using parking metre or disc system. However, these proposals are still valid today, with the exception of the construction of one two-storey car park in Muttrah Suq.

From the foregoing, very serious parking problems can occur in future in these areas with the increase in business and commercial activities, while the parking facilities which create problems are likely to persist without any improvement. The following sections provide further explanation of the parking condition in the above mentioned commercial areas.

## 7.6 - MOVEMENTS TO AND FROM THE MAJOR SHOPPING AREAS

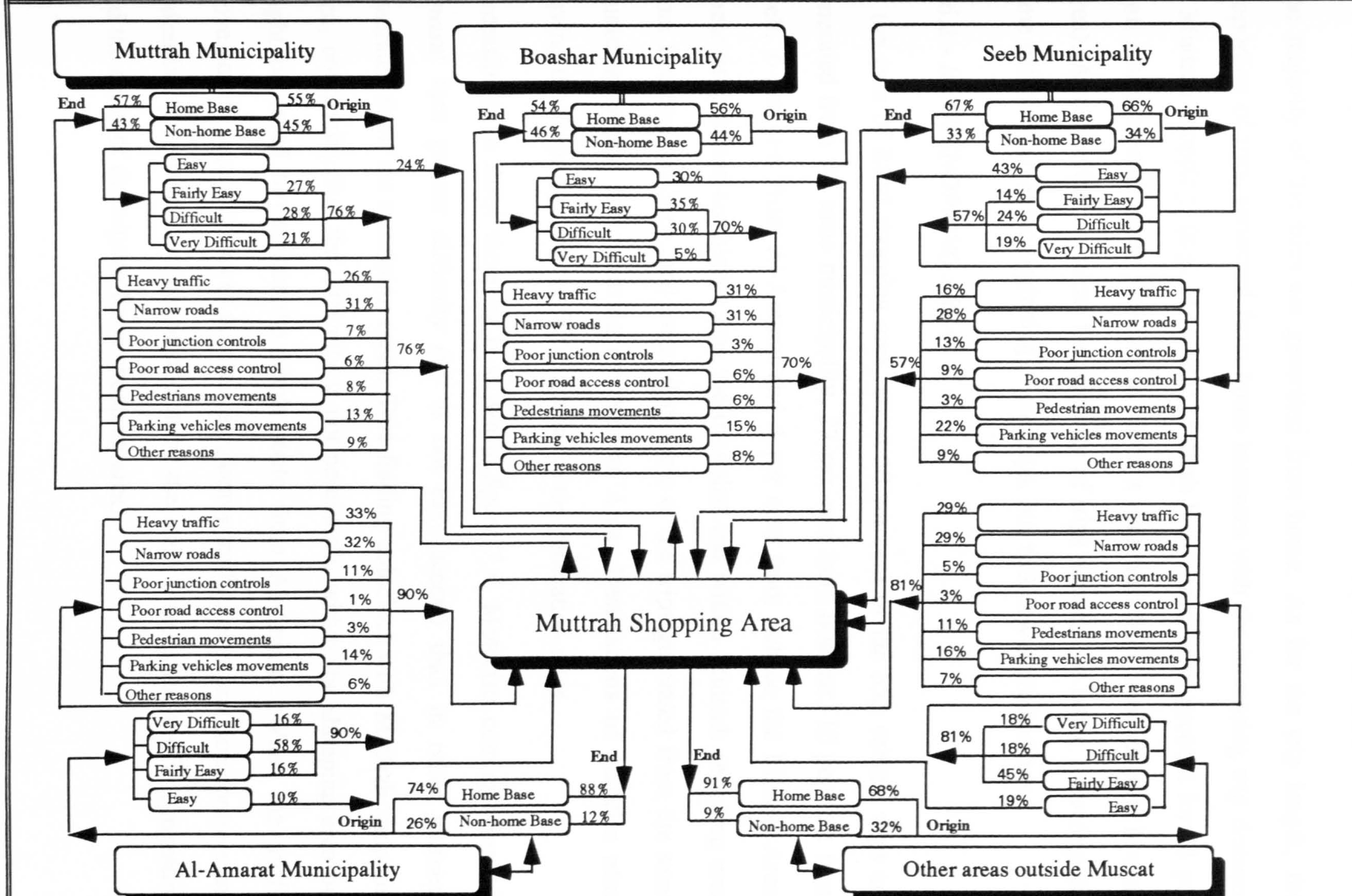
The purpose of this section is to demonstrate movement of vehicles to and from Muttrah and Ruwi shopping areas and to see whether these journeys are home based or non-home based before and after driving away from the shopping areas. The intention is also to discover the accessibility of these areas in relation to the trip origin. In other words, how easily vehicles can reach these areas.

### 7.6.1 - *MUTTRAH SHOPPING AREA*

About 54 per cent of the 260 vehicles trips that end within the Muttrah shopping area are generated from Greater Muttrah, 22 per cent from Boashar, 8 per cent from Seeb, 6 per cent from Al-Amarat and 8 per cent from areas outside the Muscat Area. When destinations of vehicles leaving the shopping area are considered, 61 per cent of total vehicles end within Greater Muttrah, 21 per cent in Boashar, 7 per cent in Seeb, 6 per cent in Al-Amarat and 5 per cent end within areas outside Muscat Area. The highest proportion of journeys to and from Greater Muttrah is not surprising because of its large population and the location of the shopping area itself within this municipality.

*Figure 7.3* shows the origin of motorists coming to Muttrah shopping in view of how easily this place can be reached. Motorists coming from Al-Amarat face more difficulty than in other journeys generated from the remaining areas. Only 10 per cent of the total trips generated from Al-Amarat easily get to Muttrah shopping area compared to 43 per cent of the motorists coming from Seeb. When the traffic movement is seen in terms of accessibility, narrow roads, heavy traffic and

*Figure 7.3*: Movements to and from Muttrah Shopping Area




Source: Reply-paid Questionnaire, Fieldwork Muscat 1990

movement of kerbside parked vehicles are considered by the motorists to be the main reasons for traffic congestion and delay of their trips to this area.

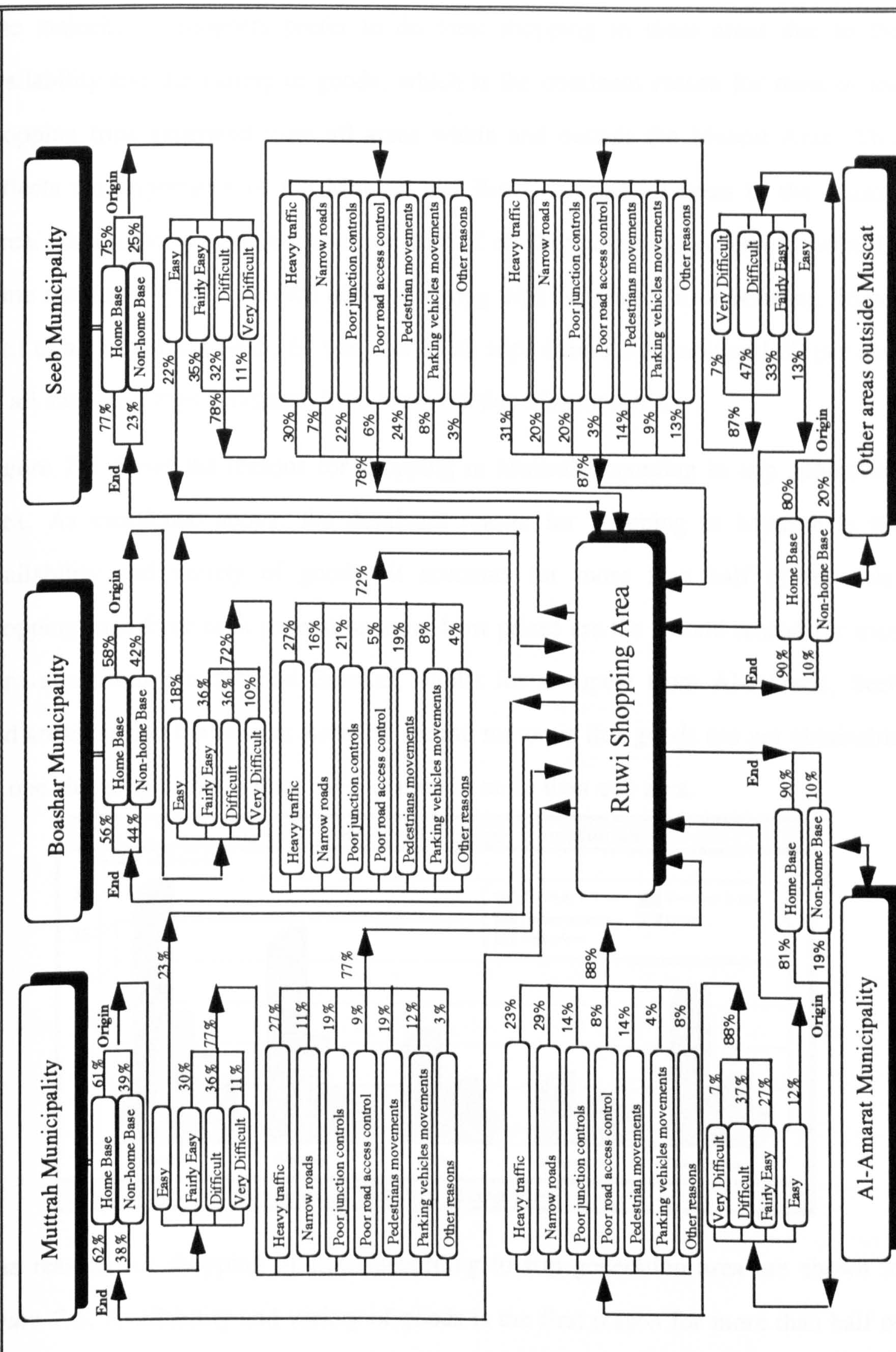
The majority of the trips are generated from home. As for the trip length, the proportion of trips generated from home increases with the increasing trip distance to Muttrah shopping, (e.g. in Greater Muttrah home-based trips account for 55 per cent, while constituting 91 per cent of all trips generated from areas outside Muscat Area). After leaving the area, the majority of trips also end at home following the same path as seen at the beginning of the trips, but with lower proportions.

### 7.6.2 - *RUWI SHOPPING AREA*

In the case of Ruwi shopping area, about 50 per cent of the 353 vehicle trips are generated from the same municipality, 27 per cent from Boashar, 10 per cent from Seeb, 6 per cent from Al-Amarat and 4 per cent from outside the Muscat Area. These proportions are higher than the trips that end within Muttrah shopping area from Boashar and Seeb, and lower than those of the trips generated from the same municipality and areas outside the Muscat Area. Destinations of vehicles after leaving the shopping area are fairly similar to the generation rates.

Accessibility to Ruwi shopping is shown in *figure 7.4.* Motorists coming from Al-Amarat face greater difficulty (88 % not easy access) than in other journeys generated from the remaining areas. This finding coincides with Muttrah shopping area, confirming that the difficulty is not necessarily within the shopping area but might be faced throughout the whole route from Al-Amarat. When the traffic movement is seen in terms of accessibility, heavy traffic, poor junction controls and pedestrian movements are considered to be the main reasons for traffic congestion and the delay of the trips to Ruwi shopping area.

*Figure 7.4*: Movements to and from Ruwi Shopping Area



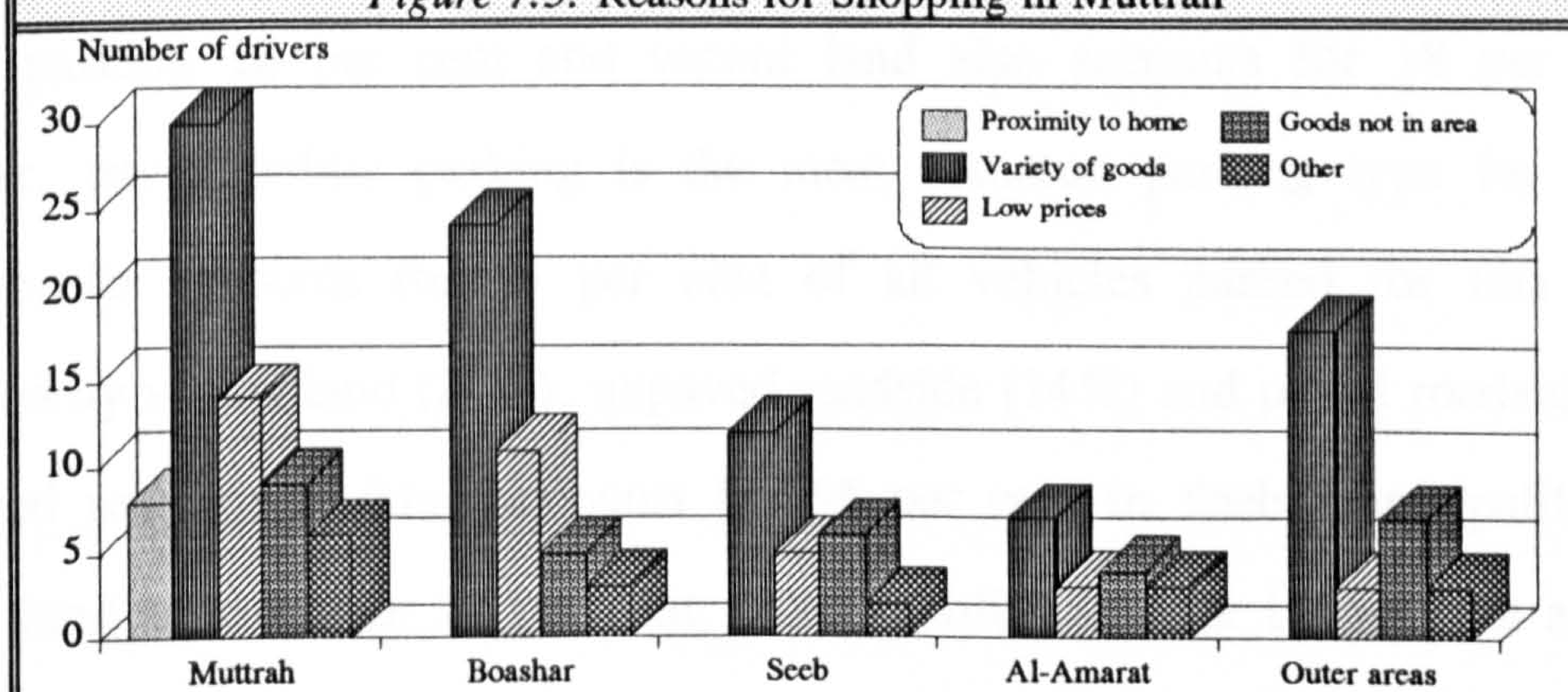

Source: Reply-paid Questionnaire, Fieldwork Muscat 1990

## 7.7 - PURPOSES FOR SHOPPING IN RUWI AND MUTTRAH

The majority of shoppers prefer to do their shopping in these areas due to the availability and the variety of goods, which is the dominant reason for most of the shopping trips generated from all areas within and outside the Muscat Area. This reflects the importance of the Muttrah and Ruwi commercial areas in the Muscat Area. This reason accounts for 48 per cent of all shopping trips generated from the same municipality, 55 per cent of all shopping trips generated from Boashar, 56 per cent of all trips from Seeb, 64 per cent of all trips from Al-Amarat and 60 per cent of all shopping trips generated from areas outside Muscat Area.

*Figure 7.5* shows the reasons for shopping in Muttrah according to trip generation area. As mentioned above, the dominant reason for shopping in Muttrah is the availability and variety of goods. It accounts for more than half of the total shopping trips from each generation area. Low prices are the second reason for trips generated from Muttrah and Boashar, whilst for shoppers from Al-Amarat, Seeb and areas outside the Muscat Area the second reason is that goods are not obtainable in one shopping area, so they have to shop in more than one area.

*Figure 7.5:* Reasons for Shopping in Muttrah

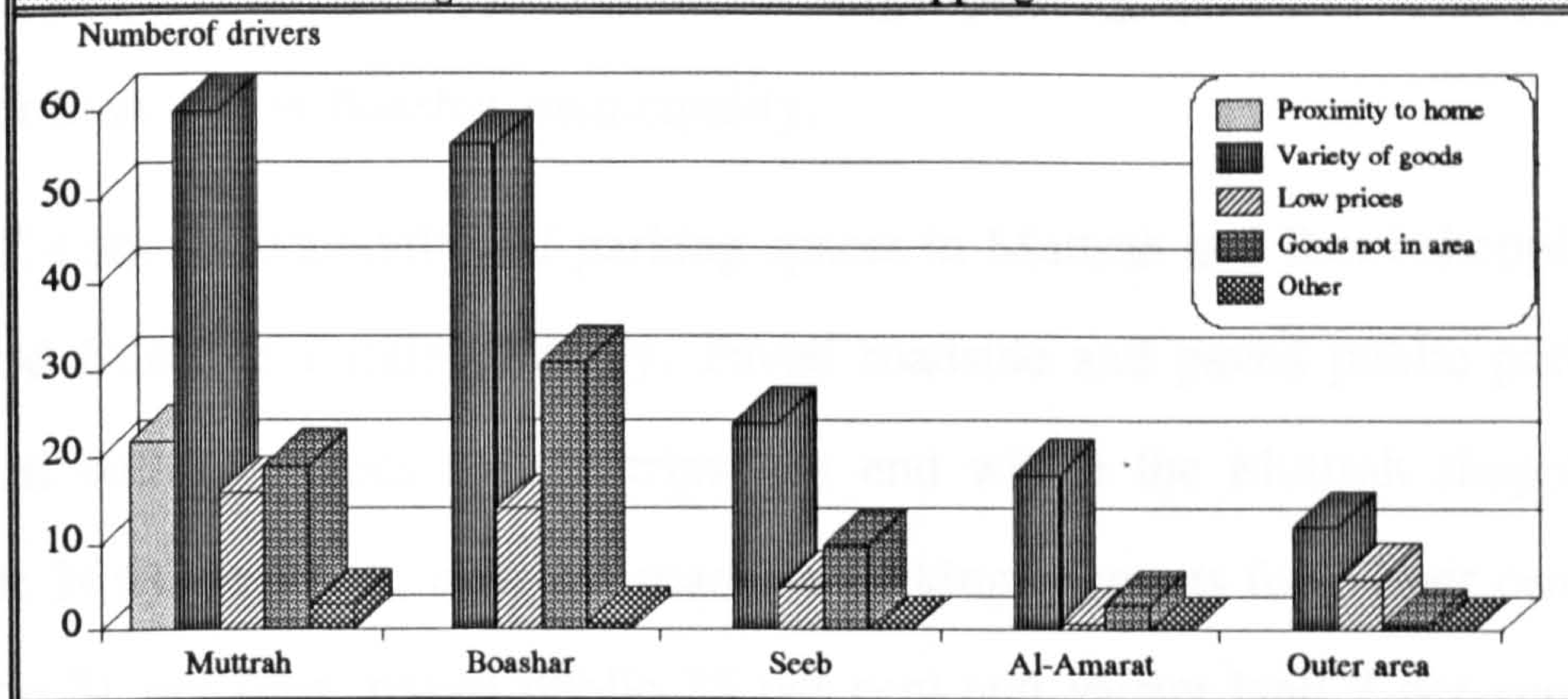



Source: Reply-paid Questionnaire, Fieldwork Muscat 1990

The reasons for shopping in Ruwi according to trip generation area are shown in *figure 7.6*. Availability and variety of goods is the first reason for more than half of the trips generated from each area. The fact that goods are not obtainable in one shopping area is the second reason for trips generated from Boashar, Seeb and Al-

Amarat. For shoppers coming from areas outside the Muscat Area the second reason is low prices.

*Figure 7.6:* Reasons for Shopping in Ruwi




Source: Reply-paid Questionnaire, Fieldwork Muscat 1990

## 7.8 - AVAILABILITY OF PARKING SPACES FOR SHOPPING PURPOSE

In order to explore the availability of parking spaces for shopping trips, vehicle drivers were requested to indicate the type and degree of difficulty of finding the parking space for this purpose. *Table 7.3* shows the availability of parking spaces for each type of parking as found from the Home Interview. Paved roadside is the most common parking type in Greater Muttrah; 38 per cent of all vehicles use in this type of parking. Unpaved roadside parking accounts for 26 per cent, paved public parking 18 per cent and vacant land also accounts for 18 per cent. In Boashar, paved public parking is the most common parking type for shopping purpose. Its accounts for 53 per cent of all vehicles parked for this purpose, followed by vacant land (21%), unpaved roadside (14%) and paved roadside (12%). Unpaved roadside parking accounts for 55 per cent in Seeb municipality, whilst vacant land accounts for 21 per cent, paved public car park 19 per cent and paved roadside only 5 per cent. This variation between the municipalities in terms of types of parking available reflects development planning and density in these municipalities, (Chapter 2).

Finding a space in shopping areas involves more difficulty than in the case of other trip purposes at present. For many shopping journeys, finding a parking space in

Muttrah involves more difficulty than in other municipalities, (e.g. 74 per cent of the total responses indicate that paved roadside parking is difficult whilst 22 per cent indicate that it is fairly easy). In Seeb, finding a parking space in the shopping areas is easier than it is in Boashar municipality.

*Table 7.4* shows availability of parking spaces in Muttrah and Ruwi shopping areas as found from the Parking Survey. Paved roadside and paved public parking are the most common types for the trips that end within the Muttrah shopping area (37% & 36%). In Ruwi, unpaved roadside parking accounts for 37 per cent, paved roadside 31 per cent, paved public 25 per cent and vacant land 7 per cent. When the type of parking is seen in terms of the difficulty in finding parking space, the findings of the Parking Survey data coincides with the Home Interview and confirms the great difficulty in finding a parking space in Muttrah and Ruwi shopping areas. The respondents who found a parking space easily were 15 per cent in Muttrah and 16 per cent in Ruwi.

When the *'not easy'* responses are investigated in terms of how they found the parking space in Muttrah, 52 per cent cruised around till they found a space, 25 waited long time in their vehicles, and 23 per cent *'other'*. In the case of Ruwi, the corresponding percentages are 57, 25 and 17 respectively. In Muttrah, the *'other'* answers represent 65 per cent of drivers who cruised around and waited a long time to find a parking space, 10 per cent drove very slowly, 4 per cent double parked, 6 per cent parked illegally and 15 per cent parked far away from their destination. In Ruwi, the others answers represent 67 per cent who cruised around and waited a long time to find a parking space, 7 per cent drove very slowly, 3 per cent were double parked, 11 per cent illegally parked and 12 per cent parked far away from their destination.

*Table 7.3*: Availability of Parking Space (Shopping- Purposes )

| Code | Municipality | Paved Public Park | | | Vacant Land | | | Paved Roadside | | | Unpaved Roadside | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | |
| 1 | **Greater Muttrah** | 3 | 4 | 15 | 11 | 4 | 6 | 2 | 10 | 34 | 2 | 9 | 20 | 120 |
| Percentage Per Each | | 14% | 18% | 68% | 52% | 19% | 29% | 4% | 22% | 74% | 6% | 30% | 64% | 100% |
| Percentage Per Type | | < ---- 18% --- > | | | < ---- 18% ---- > | | | < ---- 38% ---- > | | | < ---- 26% ---- > | | | 100% |
| 2 | **Boashar** | 10 | 16 | 1 | 11 | 0 | 0 | 2 | 1 | 3 | 1 | 4 | 2 | 51 |
| Percentage Per Each | | 37% | 59% | 4% | 100% | 0% | 0% | 33% | 17% | 50% | 14% | 57% | 29% | 100% |
| Percentage Per Type | | < ---- 53% --- > | | | < ---- 21% ---- > | | | < ---- 12% ---- > | | | < ---- 14% ---- > | | | 100% |
| 3 | **Seeb** | 2 | 6 | 0 | 7 | 2 | 0 | 0 | 1 | 1 | 12 | 11 | 1 | 43 |
| Percentage Per Each | | 25% | 75% | 0% | 78% | 22% | 0% | 0% | 50% | 50% | 50% | 46% | 4% | 100% |
| Percentage Per Type | | < ---- 19% --- > | | | < ---- 21% ---- > | | | < ---- 5% ---- > | | | < ---- 55% ---- > | | | 100% |

Source: Home Interview Survey 1990

*Table 7.4:*Availability of Parking Spaces (Shopping areas)

| Type of Parking ---> Parking -----> | Paved Public Park | | | Vacant Land | | | Paved Roadside | | | Unpaved Roadside | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | Easy | Fairly Easy | Diffi-cult | |
| **Muttrah Shopping Area** | 7 | 24 | 64 | 6 | 8 | 19 | 16 | 25 | 55 | 11 | 10 | 15 | 260 |
| Percent per each type | 7 % | 25% | 68 % | 18 % | 24 % | 58 % | 17% | 26 % | 57% | 30 % | 28 % | 42 % | 100 % |
| Percent per parking type | < ---- 36% ---> | | | < ---- 13% ---> | | | < ---- 37% --- > | | | < ---- 14 % --- > | | | 100 % |
| **Ruwi Shopping Area** | 14 | 22 | 54 | 6 | 5 | 15 | 20 | 35 | 53 | 17 | 31 | 81 | 353 |
| Percent per each type | 16% | 24 % | 60 % | 23 % | 19 % | 58 % | 19 % | 32 % | 49 % | 13 % | 24 % | 63 % | 100 % |
| Percent per parking type | < ---- 25% ---> | | | < ---- 7% --- > | | | < ---- 31% --- > | | | < ---- 37 % --- > | | | 100 % |

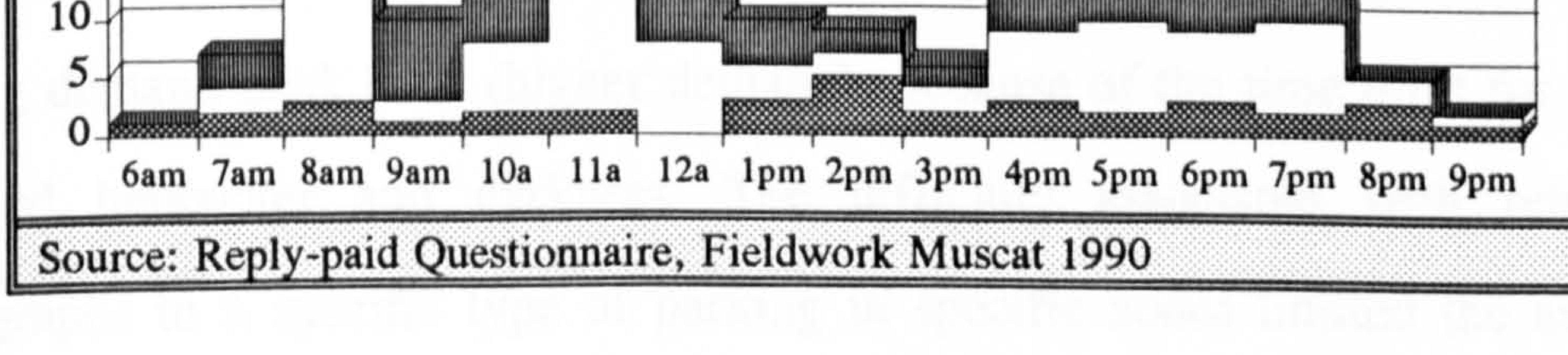
Source: Parking Survey 1990

7.8.1 - *HOURLY PARKING AVAILABILITY IN RUWI AND MUTTRAH*

*Figures 7.7 and 7.8* illustrate the hourly variation of availability of parking space in Muttrah and Ruwi shopping areas respectively. The figures themselves do not represent the actual hourly parking demand variation in these areas during that period (analysis of the reply-paid questionnaire), but roughly represent the proportion of hourly variation in finding a parking space in these areas.

It can be seen from *figure 7.7* that during the early morning hours up to 8 a.m., before the shops open, finding a parking space in Muttrah shopping is easier than during shopping hours from 9 a.m. to 1 p.m. During the early hours 20 per cent of total parked vehicles during that period find a parking space easily, 42 per cent fairly easily and 38 per cent difficult, whilst during the morning shopping hours the proportions are 8 per cent, 32 per cent and 60 per cent respectively. In the afternoon, the shops are closed, hence the demand for parking is less and finding a parking space involves little difficulty. Normally the demand for parking in the evening shopping hours (4 to 7 p.m.) is high. Of the total parked vehicles during this period, only 8 per cent found a parking space easily, 23 per cent fairly easily and 69 per cent difficult. The high demand for parking during evening shopping hours coincides with the findings of the Home and Roadside Interview (Chapter 3) which show that the evening time is the most convenient time for shoppers.

*Figure 7.7* : Hourly Variation of Availability of Parking in Muttrah

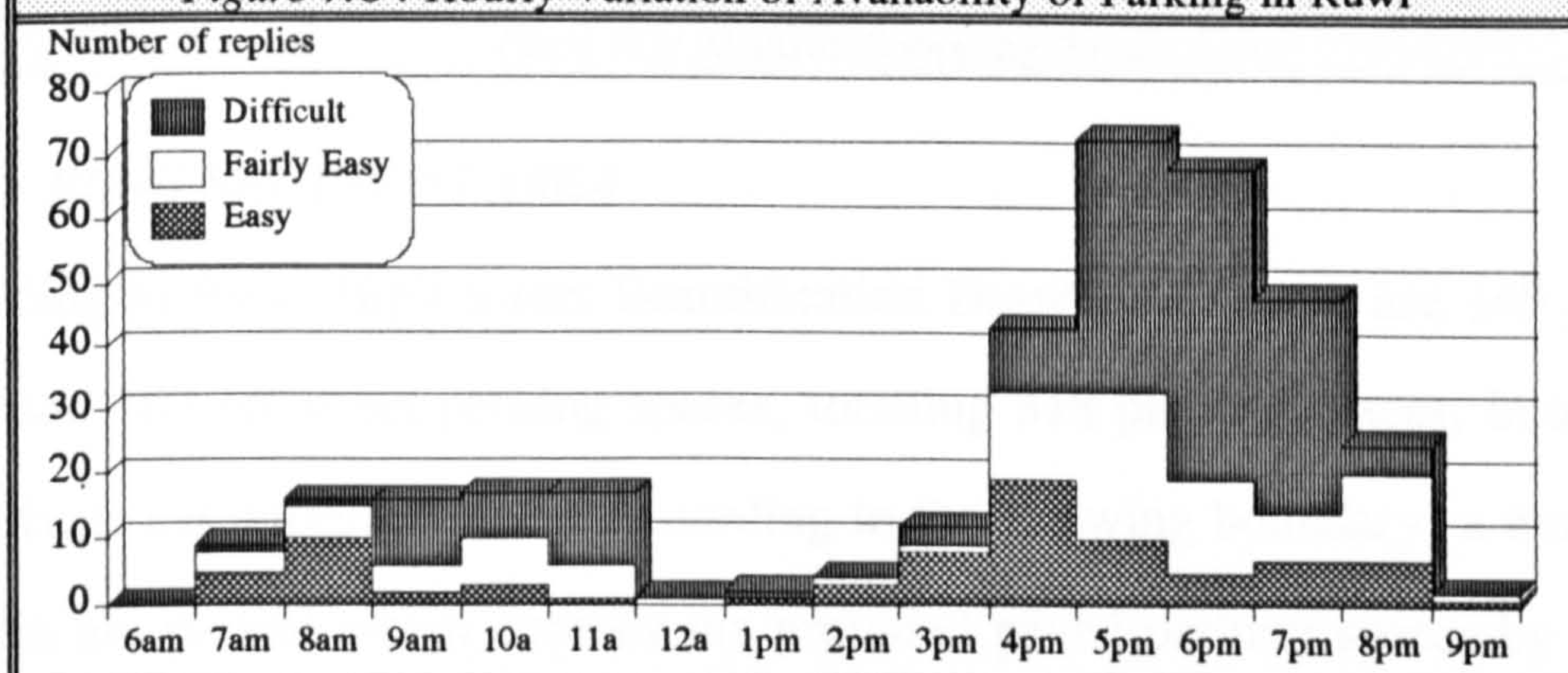



Source: Reply-paid Questionnaire, Fieldwork Muscat 1990

*Figure 7.8* shows the hourly variation of parking spaces availability in Ruwi shopping area. During the shopping hours, finding a parking space in Ruwi is easier than in Muttrah. In Ruwi during the morning shopping hours, 24 per cent of total parked vehicles found a parking space easily, 32 per cent fairly easily and 44 per cent difficult, whilst during the evening shopping hours the proportions are 19 per cent, 28 per cent and 53 per cent respectively.

When the parking difficulty is seen in terms of the worst hour to find a parking space, 11 a.m. is the most difficult hour to find a parking space in the morning shopping (64 % difficult), whilst in the evening at 6 p.m. (78% difficult) in the case of Muttrah. In Ruwi it is also 11 a.m. for the morning shopping (65 % difficult) and 6 p.m. in the evening (72% difficult).

*Figure 7.8* : Hourly Variation of Availability of Parking in Ruwi




Source: Reply-paid Questionnaire, Fieldwork Muscat 1990

## 7.9 - PARKING DEMAND ANALYSIS

Parking accumulation survey was considered the best way to collect information in order to analyse parking demand. Due to the lack of parking inventory and parking control, aerial photographs were taken in the morning-parking-demand peak hour in Muttrah and Ruwi shopping areas, and Qurum shopping area and the Central Business District (CBD) in Ruwi. It was not possible to photograph in the evening parking demand peak hour (higher demand), because of the time limit for using the provided helicopter and darkness. The difficulty associated with relating the photographs to a specific type of parking in specific zones limited the analysis to Ruwi shopping area and the CBD, (see plate 7.1).

*Plate 7.1:* Muttrah Shopping Area

### 7.9.1 - *RUWI SHOPPING AREA*

According to Ruwi High Street Beautification Drawing(16) there are 149 paved on-street and 107 off-street parking spaces, totalling 318 parking spaces, in addition to 159 private car parking spaces. According to the Drawing boundary, a total of 1327 vehicles are parked which exceeds the provided paved parking spaces by 850. This high proportion of vehicles (64%), is parked either on the unpaved roadside and vacant land or improperly parked, (e.g. double parked or on pedestrian paths).

However, private vehicles account for 80 per cent of total vehicles parked, commercial vehicles account for 15 per cent and other types of vehicles 5 per cent. When the method of parking is seen in the light of the provided paved parking spaces, 71 per cent of the vehicles were properly parked, 5 per cent were double parked and 24 per cent were improperly parked. This shortage of parking spaces and uncontrolled method of parking in the Muscat Area main shopping centre requires serious consideration from the authority in order to maintain its function in future.

7.9.2 - *CENTRAL BUSINESS DISTRICT (CBD)*

As mentioned earlier, the Central Business which is located to the east of Ruwi High Street was planned in 1974 to be the big business, commercial and entertainment centre of Greater Muttrah and the whole country. Off-street and on-street parking spaces are provided and distributed so that all parts of the area are easily accessible, but the traffic increase and the parking demand have been much higher than foreseen at that time.

The aerial photographs reveal that there are about 1479 parking spaces available in the CBD of which 530 are on-street and 949 are off-street where 152 spaces are designated for private use. Considering the number of vehicles parked, during the survey time, a total of 2032 vehicles were calculated, representing 553 vehicles more than the parking spaces provided. Of the total parked vehicles, 495 were on-street, 827 were off-street (112 on private spaces) and 710 were vehicles parked on vacant land waiting development, (see *Plate 7.2*). This high proportion of parked vehicles on vacant land despite the availability of proper parking spaces, reflects the variation in the demand within the area as the result of development density and distance to destination.

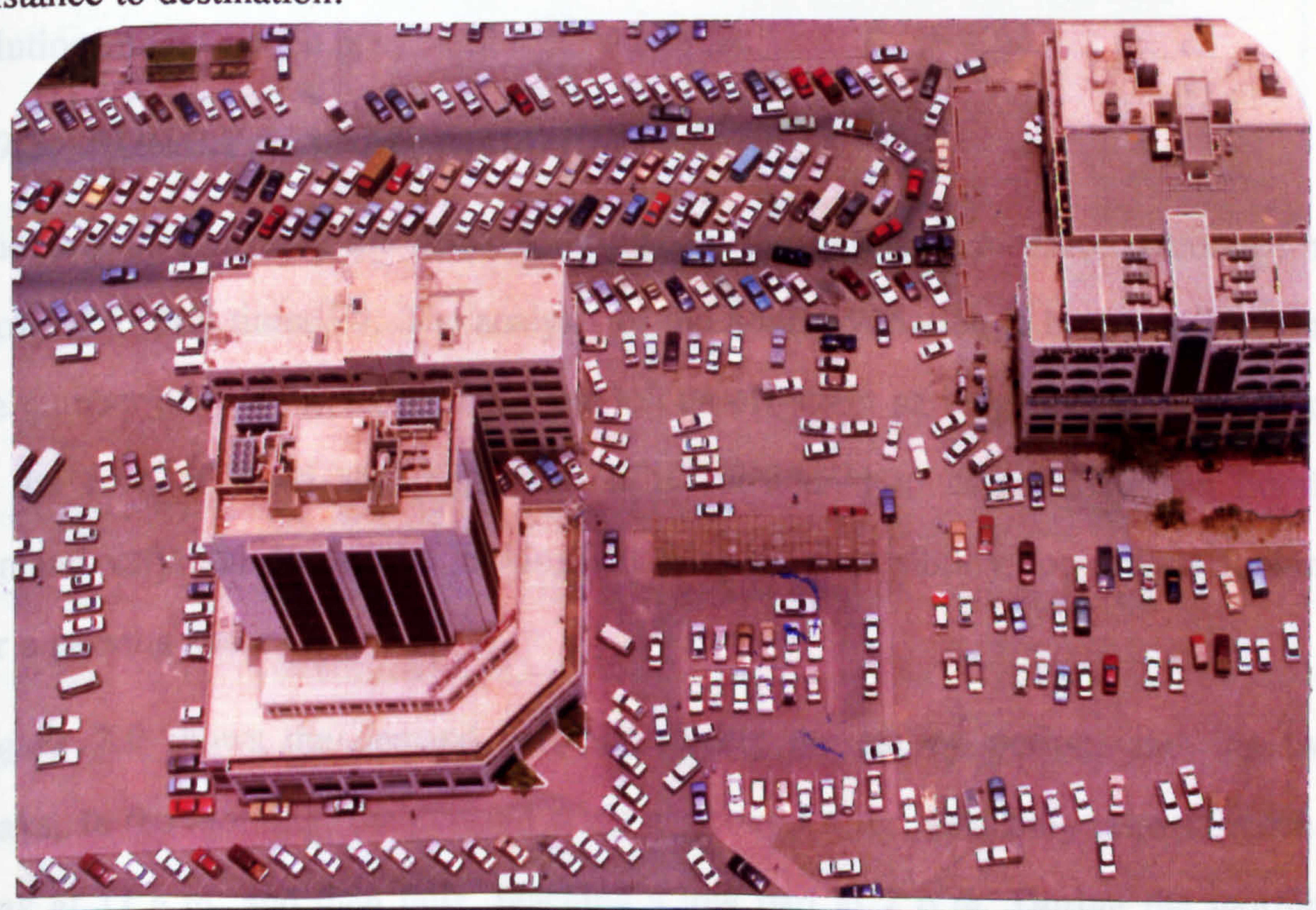


*Plate 7.2:* Vehicles Parked on Vacant Land Waiting Development

In the CBD, private vehicles account for 92 per cent of total parked vehicles, commercial vehicles for 3 per cent and other types of vehicles 5 per cent. When the method of parking is seen in terms of the available parking spaces, 89 per cent of the vehicles were parked properly, 10 per cent improperly and only one per cent was double parked.

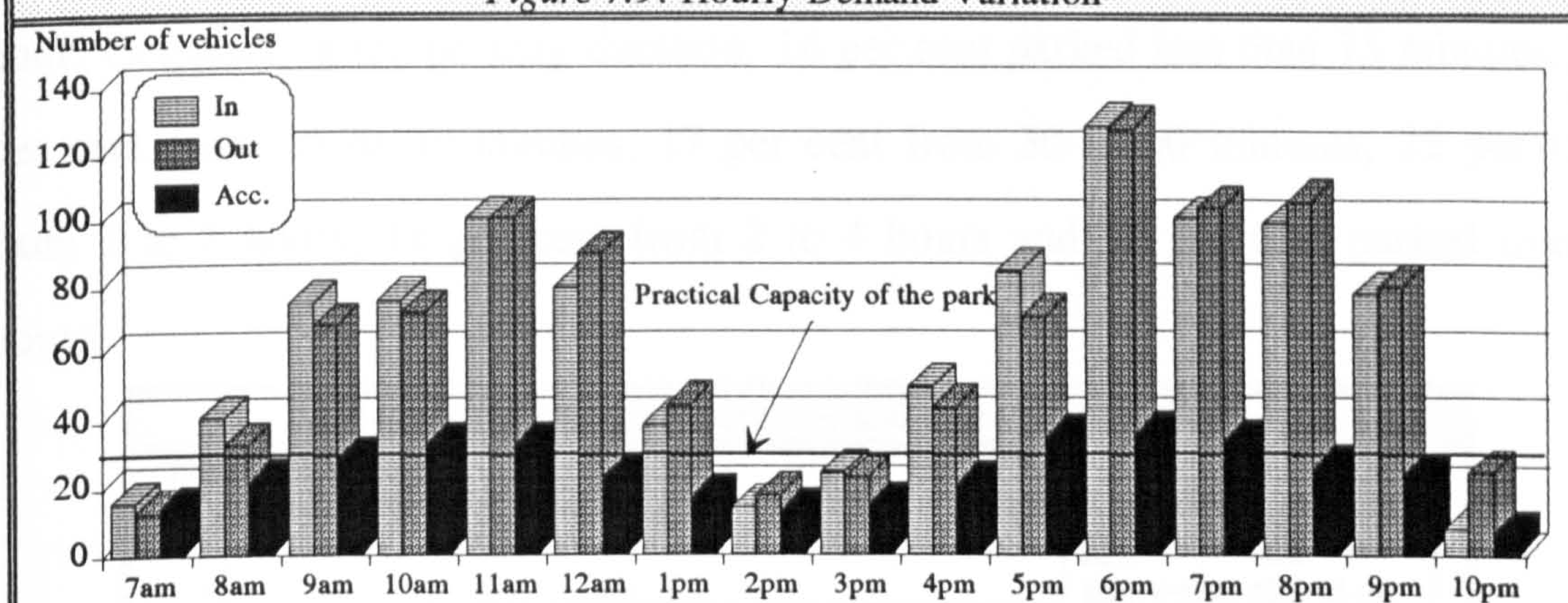
The CBD is planned to accommodate 96 multi-story buildings when it is completed. Presently, only 62 buildings exist while the remaining 33 are in the form of vacant plots privately owned and awaiting development. It is clear that the supply of parking spaces in the CBD falls short of meeting the existing demand by 37 per cent, but with present vacant plots, finding a parking space in the CBD involves very little difficulty. Looking to the future, when the area is completely built without car parking provision within each plot boundary, a serious shortage of parking spaces is expected. Considering the current average parking demand per building, there will be shortage of more than 53 per cent in the future. This shortage of parking spaces in the CBD needs to be considered. Immediate and effective solutions must be found before the condition gets worse and cost-effective solutions might not be possible.

### 7.9.3 - *HOURLY DEMAND VARIATION*

One way of analysing the demand throughout the day is to measure patronage by showing arrival times(19). The analysis of the hourly variation is based on studying the number of vehicles that entered and left an off-street parking searching for space in the core of Ruwi shopping area. It is considered to demonstrate the hourly demand variation due to the parking location and accessibility for drivers looking for a parking space.

*Figure 7.9* shows the demand variation during the survey period, showing two peaks. In the morning, the demand starts at about 7 a.m., gradually rises to reach a peak at 11 a.m. and then falls, reaching a low part at 2 p.m. During the morning peak hour, about 100 vehicles entered, 100 left the park and 33 vehicles used the park, representing 27 per cent over the practical capacity of the park. The demand is low in the afternoon, because the shops are closed and most people go home due to the hot weather. The other demand period starts at 4 p.m. when the shops open and gradually rises to reach its peak at 6 p.m. It becomes slightly higher than in the morning. After that the demand starts to decrease steeply up to 9 p.m. as some shoppers leave the area and then drops sharply when the shops close. In the evening peak hour, about 129 vehicles entered and 128 left the park. During this hour the park was continuously occupied by an average of 38 per cent over its actual capacity. The evening peak is bigger than the morning peak. This shows that the evening time is the most convenient time for shoppers as reflected by high parking demand.

*Figure 7.9*: Hourly Demand Variation




Source: Registration Number Survey, Fieldwork, Muscat 1990

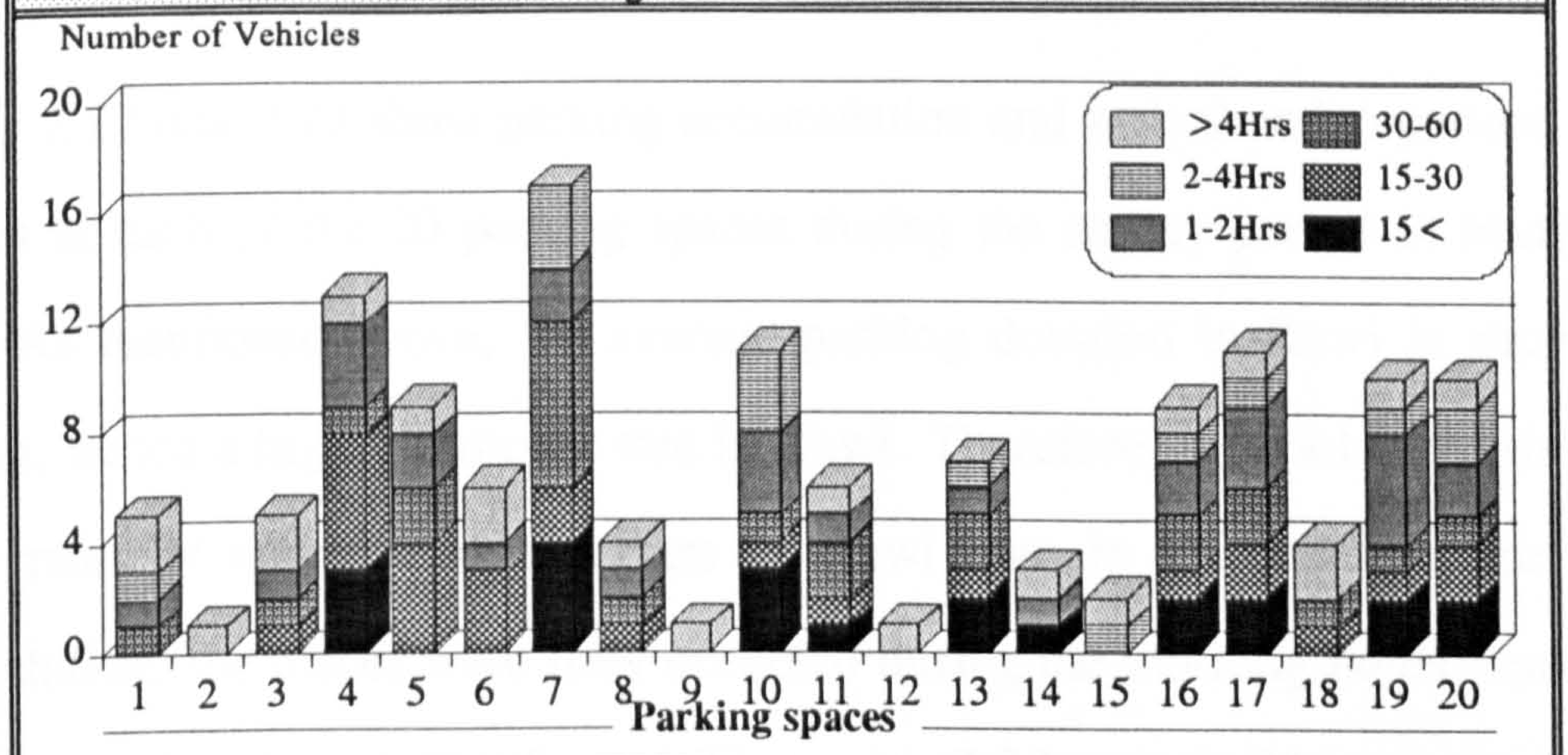
## 7.10 - PARKING SPACE USAGE

A comparison of the number of parker's over a period of time in specified parking spaces shows a clear picture of parking space usage, hence appropriate parking policy can be adopted. In order to explore the pattern of parking usage, it was necessary to carry out a patrol survey in two locations each containing 20 parking spaces in the core of Muttrah and Ruwi shopping areas to obtain information on the total number of parked vehicles, parking duration and accumulation, arrival and departure rate, and type of vehicles parked distributed geographically among those parking spaces. The following sections are detailed analysis of parking space usage.

### 7.10.1 - *TURNOVER IN THE USE OF PARKING SPACE*

Parking turnover is a rate of use of parking spaces, and is obtained by dividing the parking volume by the number of parking spaces for a specified period. In this study the turnover period is 16 hours from 7 a.m. to 11 p.m. *Figure 7.10* shows parking turnover at 20 spaces on-street car parks in the Muttrah shopping area. The average turnover per parking space is 0.4 vehicle per hour, that is, a vehicle for every two and half hours per parking space. This low rate of turnover results from the lack of regulations to control the use of parking spaces. For example, spaces 2, 9 and 12 were each occupied by one vehicle throughout the 16 hours of the survey period. Space number 7 shows the highest turnover rate which is 1.1 vehicle per hour. Considering the parking duration, 16 per cent parked less than 15 minutes, 18 per cent from 15 to 30 minutes, 17 per cent from 30 to 60 minutes, 22 per cent from 1 to 2 hours, 11 per cent from 2 to 4 hours and 16 per cent parked over 4 hours.

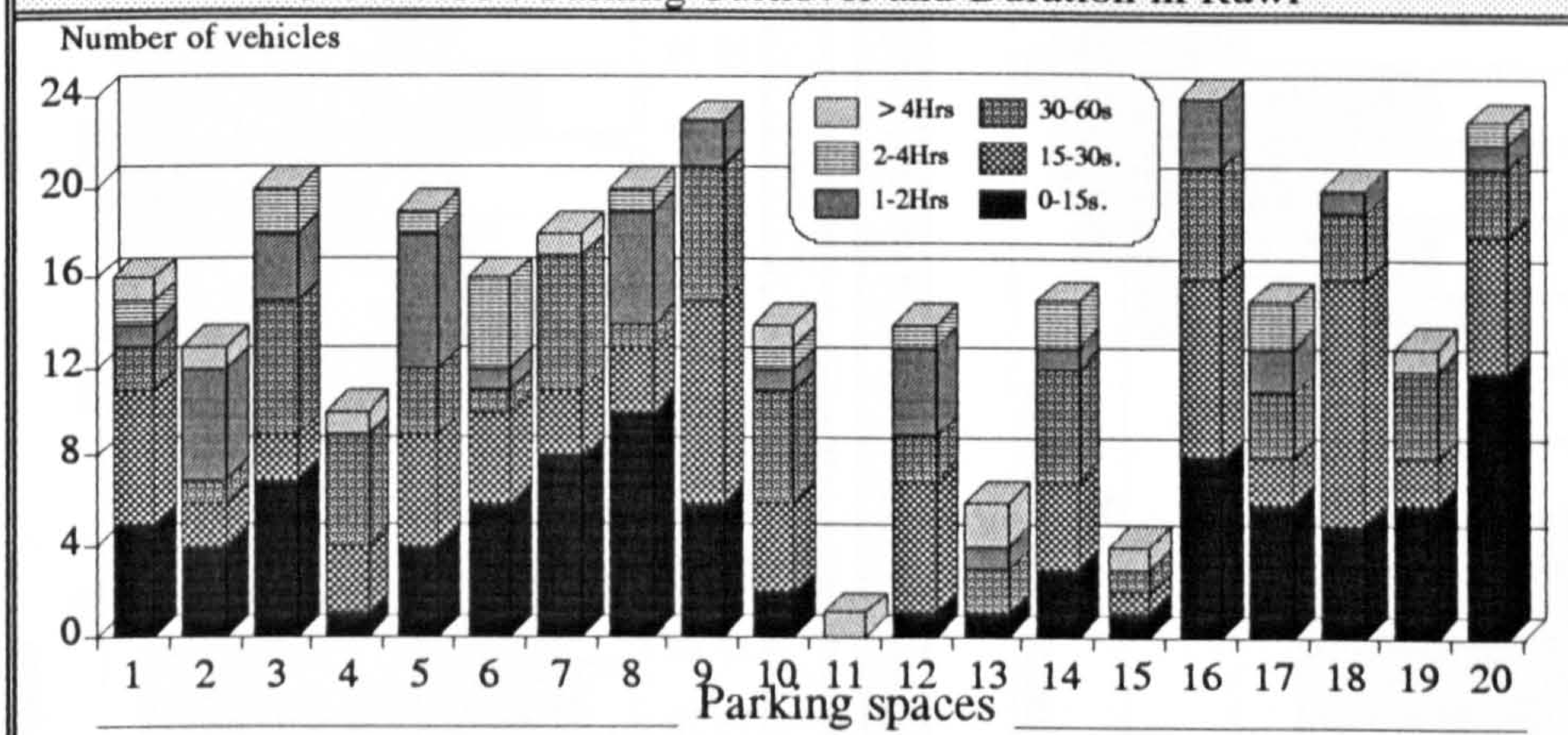
*Table 7.10* : Parking Turnover and Duration in Muttrah




Source: Patrol Survey, Fieldwork, Muscat 1990

*Figure 7.11* shows parking turnover and parking duration at 20 space on-street car parks in Ruwi. The average turnover per parking space is 0.93 vehicle per hour, nearly a vehicle for every hour per parking space, which is more than twice the average turnover in Muttrah. This better rate of turnover in Ruwi resulted from the fact that only one parking space was occupied during the survey period compared with three in Muttrah. The highest turnover rate per space is 1.5 vehicle per hour. As for the parking duration, 32 per cent vehicles parked for less than 15 minutes, 28 per cent from 15 to 30 minutes, 22 per cent from 30 to 60 minutes, 11 per cent from 1 to 2 hours, 4 per cent from 2 to 4 hours and 3 per cent parked for over 4 hours. Comparing conditions in Muttrah and Ruwi, the average parking duration in Ruwi is shorter than Muttrah as seen from the higher turnover rate in Ruwi.

*Table 7.11 :* Parking Turnover and Duration in Ruwi




Source: Patrol Survey, Fieldwork, Muscat 1990

## 7.10.2 - ARRIVAL AND DEPARTURE RATES

*Figures 7.12 and 7.13* show parking accumulation and arrival and departure rates of vehicles at each of the 20 parking spaces during the survey period in Muttrah and Ruwi. As mentioned above, the average parking duration in Ruwi is shorter than Muttrah, hence a higher turnover rate in Ruwi. Therefore, it is not surprising to see higher rates of arrival and departure in Ruwi than in Muttrah. As for parking accumulation, the places were fully occupied during the morning hours from 9 a.m. to 1 p.m. and in the evening from 4.30 p.m. to 7.30 p.m. in Muttrah. In Ruwi the places were fully occupied from 10 a.m. to 1 p.m. in the morning and from 5 p.m. to 9.30 p.m. in the evening, which is consistent with the findings of the hourly demand variation, (section 7.8.1).

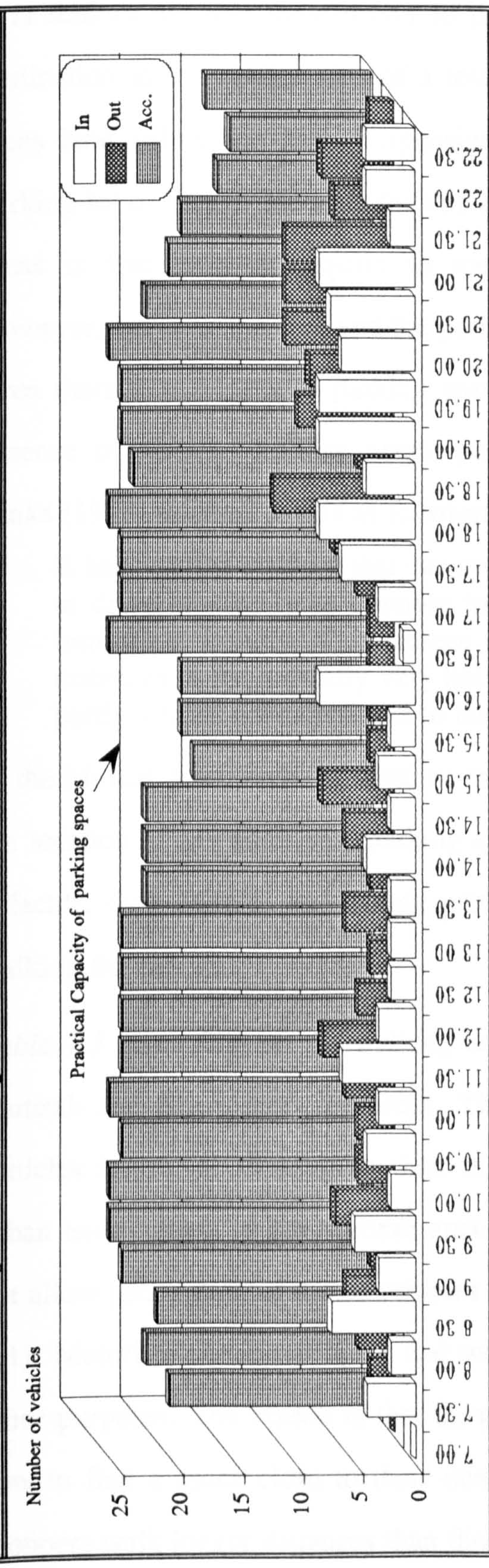



*Figure 7.12*: Parking Accumulation, and Arrival and departure Rates in Muttrah Shopping Area

Source: Patrol Survey, Fieldwork Muscat 1990

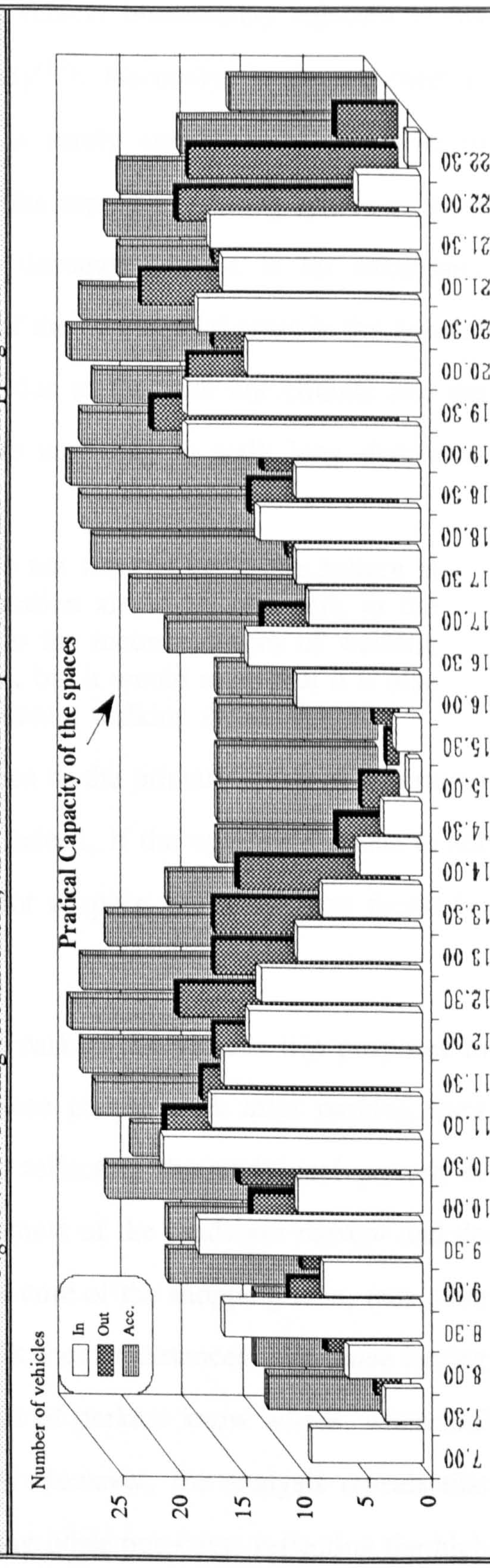



*Figure 7.13*: Parking Accumulation, and Arrival and departure Rates in Ruwi Shopping Area

Source: Patrol Survey, Fieldwork Muscat 1990

## 7.11 - WALKING DISTANCES TO DESTINATION

It is seldom possible for a driver to park his vehicle immediately adjacent to his destination in the central area of a town or city[17]. Normally, in the commercial areas land values are high. Expensive land is rarely economically adaptable to parking lot or garage use and, for this reason, the supply of parking spaces in these areas is frequently inadequate to meet the demand; Muscat is no exception. However, between the core and the perimeter of the commercial areas in the Muscat Area there is a surplus of parking space, but due to the very hot climate and the absence of pleasant walking areas, people are unwilling to walk long distances. Viaks (1983) referred to this as follows:

> It has become obvious that car owners do not want to walk, the pattern is to drive as closely as possible to the location aimed at, and park in the immediate vicinity. This pattern is due to the inconveniences of walking distances in the normally very hot climate, but it would seem that it is also partly a habit developed due to lack of pleasant walking areas[12].

In the Muscat Area, walking distance can be seen as the primary factor to determine the location of any additional parking spaces. Indeed, if the walking distance is not a factor, then there is no parking problem, for a space can always be found by walking far enough.

*Table 7.5* gives data on the walking habits of parkers for various trip purposes in Muttrah and Ruwi shopping areas. The distance people walk after parking their vehicles is greater in Muttrah than in Ruwi, reflecting the traditional pattern of urban environment in the Muttrah area where most of the roads are narrow and do not allow penetration of motor vehicles into the core of the shopping area, (see *plate* 7.1). Motorists parking at home and work walk shorter distances than those having other purposes. The reason is that those groups of parkers know where, when and how to find a space close to their destination. However, the analysis reveals that shoppers walk longer distances than those having other purposes, reflecting the high parking demand during shopping hours, hence it forces the motorists to park far away form their destination.

*Table 7.5* Distance Walked from Parking Place to Destination by Trip Purpose

| Distance To Destination | Home | | Work | | Business | | Shopping | | Others | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| **Muttrah Shopping Area** | | | | | | | | | | |
| Less than 250 m | 20 | 54% | 29 | 56% | 10 | 42% | 50 | 37% | 5 | 45% |
| 250 - 500 m | 8 | 22% | 14 | 27% | 7 | 29% | 55 | 40% | 3 | 28% |
| 500 m - 1 km | 7 | 19% | 6 | 11% | 6 | 25% | 27 | 20% | 2 | 18% |
| More than 1 km | 2 | 5% | 3 | 6% | 1 | 4% | 4 | 3% | 1 | 9% |
| Total | 37 | 100% | 52 | 100% | 24 | 100% | 136 | 100% | 11 | 100% |
| **Ruwi Shopping Area** | | | | | | | | | | |
| Less than 250 m | 7 | 64% | 58 | 76% | 24 | 52% | 108 | 52% | 7 | 50% |
| 250 - 500 m | 3 | 27% | 14 | 19% | 15 | 33% | 67 | 33% | 5 | 35% |
| 500 m - 1 km | 1 | 9% | 3 | 4% | 5 | 11% | 26 | 13% | 2 | 15% |
| More than 1 km | 0 | 0% | 1 | 1% | 2 | 4% | 5 | 2% | 0 | 0% |
| Total | 11 | 100% | 76 | 100% | 46 | 100% | 206 | 100% | 14 | 100% |

Source: Reply-paid Questionnaire, Fieldwork, Muscat 1990

## 7.12 - DRIVERS OPINION IN INTRODUCING PARKING FEE

In the past, drivers expected to park very close to their destination, with a marked reluctance to walk any appreciable distance. Therefore, the development of parking regulations such as parking meters to control the use of on-street parking were an unacceptable solution. Llewelyn Davies (1983) commented on this:

> Informal discussion on parking with the Royal Oman Police suggest that the introduction of meters, traffic wardens and on-street parking regulations would not be accepted by drivers at this stage. However, as the problems of parking increase, drivers will become more amenable to accepting some degree of control(18).

Nowadays, with the increase in parking difficulty particularly in the commercial areas, shoppers and other casual visitors to the areas find great difficulty as the available spaces are occupied earlier in the day by the employees working in the area. In order to see the drivers opinion regarding a parking fee for an easy accessible space, vehicle drivers were requested to indicate their opinion regarding this matter. Of the total replies 71 per cent were in favour of the suggestion while 29 per cent were against it. When the answers are seen in view of trip purposes, the vast majority of drivers are in favour except the motorists parking at home and for work. *Table 7.6* shows the drivers' opinion regarding a parking fee for various trip purposes in Muttrah and Ruwi shopping areas.

*Table 7.6* Drivers' Opinion Regarding a Parking Fee

| Fee for Parking | Home | | Work | | Business | | Shopping | | Others | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| Muttrah Shopping Area | | | | | | | | | | |
| Yes | 17 | 46% | 25 | 48% | 15 | 63% | 115 | 85% | 8 | 73% |
| No | 20 | 54% | 27 | 52% | 9 | 37% | 21 | 15% | 3 | 27% |
| Ruwi Shopping Area | | | | | | | | | | |
| Yes | 4 | 45% | 31 | 41% | 28 | 61% | 181 | 88% | 8 | 57% |
| No | 6 | 55% | 45 | 59% | 18 | 39% | 25 | 12% | 6 | 43% |

Source: Reply-paid Questionnaire, Fieldwork, Muscat 1990

## 7.13 - CONCLUSION

With the rapid increase in the number of motor vehicles and their use in the Muscat Area, the issue of vehicle parking is a serious and difficult problem, especially around the commercial and government administration areas. In the face of this growing demand for parking spaces, the available spaces at the present time are quite primitive. The on-street parking spaces are very limited and most of the currently used off-street ones are on private lots which are awaiting development, making the problem even worse in the absence of an immediate solution.

Parking problems in old parts of Muscat Area were recognised in the early '70s as the result of increases in the number of privately owned vehicles and their use in urban environment pattern related to non-motorised mode of transport. The topographical nature of the area, particularly in Greater Muttrah, limited the flat land available for the development infrastructure, resulting in an acute shortage of parking spaces in this area. Due to the lack of defined on-street parking spaces and regulations coupled with the hot weather, motorists simply drive off the road and park their vehicles anywhere along the road as close as possible to their destination to avoid the heat. This method of parking results in the disorganised accumulation of vehicles which effects the streets capacity, and creates congestion and delay in the traffic flow.

Vacant land is the most common type of parking use in Muscat Area followed by paved private parks, paved public parks, paved roadside parks and finally unpaved roadside. At present, finding a parking space in the Muscat Area involves little difficulty in the case of overall parking conditions despite trip purpose and destination area. However, for many journeys finding a parking space in Muttrah involves much difficulty, particularly in paved roadside parking spaces. A high proportion of parked vehicles at all destination purposes other than at work do park for periods less than one hour.

In Greater Muttrah, paved roadside spaces are the most common type of parking used; 38 per cent of all vehicles use this type of parking. In Ruwi shopping area, most of the 1327 vehicles were parked over the limit of the provided spaces. They are parked either on unpaved roadside spaces and vacant land or improper parking. The supply of parking spaces in the CBD falls short of meeting the existing demand, but as there are vacant plots, at the moment finding a parking space in the CBD involves very little difficulty. When the area is completely built, a serious shortage of parking spaces is expected. Considering the current average parking demand per building, there will be a shortage of more than 53 per cent in the future. This shortage of parking in the CBD needs to be considered.

When the turnover of 20 spaces on-street car parks in the Muttrah shopping area is investigated, the average turnover per parking space is a vehicle for every two and half hours per a parking space. This low rate of turnover resulted from the lack of regulations to control the use of parking spaces. In Ruwi, the average turnover per parking space at 20 space on-street car parks is a vehicle for every hour per parking space which is more than twice the average turnover in Muttrah. The average parking duration in Ruwi is shorter than Muttrah which is reflected by a higher turnover rate in Ruwi.

The distance people walk after parking their vehicles is greater in the Muttrah than in Ruwi. Motorists parking at home and at work walk shorter distances than those having other purposes. The reason is that those groups of parkers usually park their vehicles in off-peak hours demand and have no difficulty in finding a parking space close to their destination. Generally, shoppers walk long distances than those having other purposes, reflecting the high parking demand during shopping hours. The majority of the drivers agree to pay a parking fee for easy accessible parking space in the shopping areas. When their responses were seen in view of trip purposes, apart from motorists parking at home and at work, most of them were in favour of the idea.

From the foregoing, vehicle parking is obviously a very serious problem that requires effective solutions. With the increasing of the number of commercial activities in the problematic areas, parking problems are expected to be worse in the absence of an immediate solution.

## 7.14 - RECOMMENDATIONS

Demand for parking is acute. The problems caused by this demand require a thoughtful solution and the establishment of new policies. Unless parking facilities are provided and controlled in the problematic areas, people may be discouraged from making journeys to these areas which, in turn, may affect the importance of their economy.

There is a need to introduce parking policy in conjunction with reserving and acquiring suitable sites for parking purposes as close as possible to the major shopping and business areas. It is desirable to develop policy options that should make effective use of parking space, reduce traffic congestion and accidents, and can provide a balance between parking demand and the capacity of the road network. It is inadequate to rely on using undeveloped sites or lots which are awaiting development for parking purposes. Providing adequate car parks is essential to the life of the commercial and business areas in the Muscat Area. Trade is the focal point of the commercial areas and in the absence of sufficient parking spaces retailers suffer first when parking and congestion are not relieved.

The improvement of parking provision should relieve traffic congestion and related problems. The supply of car parks should be related to the capacity of roads that carry the traffic to the area concerned and their distribution can be uniform throughout the area. There should not be a situation where sufficient parking is provided in one part whilst no parking is provided in another part. Parking planning, siting and operation must be related to type and size of activity to be served. The wise siting of car parks can increase the number of vehicles that can be parked in the urban area, without causing congestion and traffic accidents

There is a need for two types of parking in order to meet the demand in the major shopping and business areas. One is short-term for those who come for shopping and business. These motorists usually tend to avoid the peak periods and park for shorter periods, permitting multiple use of the same parking space. The other is long-term for those who work and live in the area and need to park for a long period of time. It is understood that the existing parking spaces fail to satisfy the demand of all motorists in the commercial areas. Therefore, new parking spaces must be provided, but it is widely acknowledged that the supply of parking facilities in the central areas are limited and expensive.

Therefore, new policies can be formulated to allow a maximum use of the existing parking spaces and where parking is lacking new spaces must be provided. As shoppers and business callers are essential to the economic prosperity of the commercial areas, priority can be given to accommodating these parking demands conveniently. Whilst long-term parking facilities could be located close to the core of the commercial areas, such car parks can provide reasonable access, and walking distance can be less than 300 metres whenever possible.

Long-term parkers account for a third of the parked vehicles in Muttrah while this figure is slightly less in Ruwi shopping area. Therefore, long and short-term provision of car parks in each area can be based on these proportions. Paved and unpaved on-street car parks are the most common types in the shopping areas. Considering public parking - parking available to general public - in Muttrah on-street and off-street parking have roughly equal share of use, while on-street have a higher use than off-street due to their availability.

To improve the health of the commercial areas in Muttrah through relieving traffic congestion in narrow streets, curb parking can be gradually eliminated. Curb parking regulations to control the use of available space can temporarily help the parking situation, but permanent relief can come only from off-street parking development. It is desirable to use the existing on-street parking spaces to improve the accessibility to the area and to the proposed car parks. The provision of off-street car parking can be in the form of multi-storey car parks on sites where there is no substantial development. The location of car parks can be viewed in response to the accessibility by both long and short-term parkers and provided with the necessary means of signs and regulations to improve their accessibility. Off-street car parks may be more effective if they are provided widely and their location relates closely to the destinations of most motorist.

Multi-storey car parks seen to be the most expensive, but are cost effective considering the traditional value of the shopping area and the high parking demand in high density built-up areas where open site car parks are not possible. When creating new multi-story car parks, the design specifications can take into account drivers' demand, (e.g. the ground level should be located for those with the lowest parking duration). However, a certain mount of demolition will be necessary in order to provide enough parking spaces in the Muttrah shopping area.

On-street car parking makes up the major part of the current parking facilities in Ruwi shopping area. In order to meet the parking demand some form of kerb parking management is needed in conjunction with some provision of off-street car parks. At present, the study envisages an efficient utilisation of the existing spaces. The investment on the improvement of parking may start with controlling the use of the existing spaces in order to meet short-term parkers. For long-term additional off-street parking spaces can be provided within an easy walking distance from any point on the Ruwi High Street. Such walking distance may not exceed 250 metres from the car park and to the location aimed at. With the increasing numbers of vehicle trips to the area, it is inevitable that some of the existing and the proposed car parks will have to be modified to multi-storey in order to increase their capacity.

In the CBD, there will be a shortage of more than 53 per cent of parking spaces in the future. Such a high supply of spaces can come only from off-street parking development. Therefore, the landscapes in the middle of the area which are provided for outdoor sports facilities and children's playgrounds can be converted into under-ground car parks and in future to multi-storey car parks to meet the demand. The upper level of the parks can be used for the same purposes as planned. As for the existing car parks, parking policy can be adopted that could encourage the short-term parkers and deter the long-term parkers and provide a balance between the demand and the capacity of the road network .

The need to impose a time-limit parking scheme resulted from the low turnover, high occupancy of kerb parking space and the high number of cruising vehicles waiting for the opportunity to park. If no limit is placed to control the lengths of time that vehicles can park, many available spaces may continue to be used by the comparatively few long-term parkers deterring a greater number of short-term parkers. However, it is desirable to consult the people concerned before the introduction of time-limit control in order to take into account their views and to justify the introduction of such a scheme. Many methods are used to ensure a continuous turnover of parking space. Parking meter control, parking ticket control and limited waiting schemes under direct police or warden control are considered to be the best control options to be used, where necessary, in the commercial areas. All of these methods can be used in on-street and off-street car park control.

The motorist should have no doubt as to where, when and for how long a vehicle may be parked. Therefore, the controlled area must be clearly defined by distinctive road and kerb markings combined with proper signing and the time-limit parking should be properly enforced in it. The most efficient way of enforcing the parking restrictions in controlled zones is to use patrolling traffic wardens - this applies irrespective of whether parking is free or a charge is made(2).

Limited waiting schemes are the places where the authorised time limits are displayed on signs which also show the extent of permitted (free) parking. This kind of time-limit parking control is relatively effective at locations where the total parking spaces available is sufficient to meet the parking demand. Therefore, the parker has little difficulty in leaving his or her vehicle close to the destination without exceeding the specified time limit, hence no great effort is required in relation to enforcement. The parking meter is primarily designed to assist in the enforcement of parking regulations, and to increase parking turnover. The meter can be set to allow parking for a fixed period of time for a fixed charge and as soon as the motorist has used up the allotted parking time, a signal is displayed on the meter which can be easily seen by a patrolling traffic warden or police officer. The parking tickets method is known as pay-and-display parking. Ticket machines sell parking tickets which are displayed for inspection to ensure that the parked vehicle has not exceeded the time limit.

The question of which of the time-limit controls is to be imposed depends on the advantages and disadvantages of controlling method within the overall parking policy that can meet the demand and public service vehicles in the commercial areas. However, terminal facilities, being the basis of any transportation system, must be planned with the type of parker to be served within the broader context of overall transportation policy.

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# CHAPTER 8
# PUBLIC TRANSPORT

## 8.0 - INTRODUCTION

The provision of access and mobility is the essence of modern life. In the Muscat Area, the majority of people have increased their mobility through access to private modes of transport, but increasing mobility creates serious social, economic, and environmental problems. The continuous increase in the number of cars on the road network poses further threats to traffic movements. As mentioned earlier, the area is already suffering from traffic congestion and accidents arising from the flow and parking of motor vehicles.

Car availability per household is very high in the Muscat Area. Private vehicles are the dominant mode of travel and their role may continue in future since very large increases in car ownership are expected during the next 20 years. Weidleplan (1990) anticipated that the demand for public transport would remain almost static despite the increase in the population from 405,00 in 1989 to 730,000 in the year 2010(1). It is proving difficult for the existing transport facilities to cope with the increasing number of private vehicles. In the absence of methods and plans to deter private vehicles, it is probably only a short time before the traffic flow in the Muscat Area reaches a situation where the road network will not be able to accommodate the unlimited rise in the number of vehicles.

The reasonable solution to these traffic problems lies in developing an efficient public transport system which can provide an attractive and convenient alternative to the private vehicle. Public transport services are badly needed for those who cannot afford a car or cannot drive. These include the poor, housewives, the elderly, children, and the foreign labourers. The absence of effective public transport could worsen the quality of urban life in particular for the underprivileged groups of the society.

This chapter describes the existing public transport system in the Muscat Area. It begins with the various forms of public transport discussing the role of each mode, its operation and the associated problems. It focuses on public bus transport covering in some detail the physical characteristics and conditions of the bus service, and shows public attitude towards the bus transport. It also discusses the problems facing the potential public transport users and puts forward suggestions that may improve the role of public transport.

## 8.1 - FORMS OF PUBLIC TRANSPORT

The low-density development of the Muscat Area in conjunction with the heavy preference for private transport do not satisfy the requirements for the justification of expensive fixed track mass transit system, since there are no corridors of very heavy public transport demand(2). Therefore, the public transport system has to be road-based, which implies continuing reliance on buses, taxis and pick-ups. The bus service is provided by the Oman National Transport Company (ONTC), which currently serves nine routes in the Muscat Area. In addition, ONTC provides contracted bus services for major employers to carry their personnel to and from work. Taxis and pick-ups are privately owned and mostly driven by their owners. These forms of public transport are not regulated by law and compete actively for customers with the bus service; indeed pickups are often observed soliciting their customers from bus stations ( see *plate 8.1*).

As mentioned earlier (Chapter 3), travel by public transport accounts for about 5 per cent of all person trips in the Muscat Area. Of the total who travel by public transport, 40 per cent use taxis, 38 per cent use pickups and only 22 per cent use the ONTC buses. The strengths of taxis and pickups lies in their high availability for the public transport users compared with the ONTC buses. They offer a higher frequency, higher journey speed and the convenience of picking and setting down passengers at any place. In addition, taxis provide door to door services. The ONTC buses on the other hand, operate at low frequency on few routes with fixed stops between the main terminals. Therefore, it is not surprising that taxis and pickups have a higher share of riders than the ONTC buses.

*Table 8.1* illustrates Muscat residents' opinion on the availability of public transport in the residential areas, the commercial area and along the main roads. The overall opinion is that taxis are more available in the commercial and in the residential areas than other modes of public transport, followed by the pickups. The availability of all modes of public transport along the main roads is higher than in the other areas and pickups are the most common type of public transport. Finding public transport in Greater Muscat involves little difficulty in the case of Boashar where the areas away from the main roads are poorly served. This also applies to non-car-owners households.

When the household members were requested to indicate their opinion regarding the public transport services, 10 per cent consider them as very good, 37 per cent good, 45 per cent poor and 8 per cent very poor. Boashar is the municipality with the worst public transport services; only 4 per cent of all households consider the public transport service to be very good. Twenty eight per cent consider public transport good, 53 poor and 15 very poor. This reflects the low-density development of Boashar with high car-ownership which resulted in low demand for public transport. Hence the availability of public transport is very poor with the exception of the areas around Qaboos Highway.

### *8.1.1 - TAXIS*

Taxis in the Muscat Area are ordinary saloon cars privately owned and are mostly driven by their owners. In 1991, there were about 2,546 taxis on the roads in the Muscat Area(3). Taxis work both as individual and as shared taxis with an average capacity of four passengers. In the absence of meters, the driver has the opportunity to ask the fare he considers appropriate. Although there are fixed maximum rates, actual rates often depend upon the negotiation skills of the passengers, journey length and time of the day. Therefore, uniformity of rate application is often


*Plate 8.1:* Pick-ups Operating in Ruwi Bus Station

*Table 8.1* :Public Opinion on the Availability of Public Transport in Commercial areas, Residential Areas and along the Main Roads

| | Commercial areas | | | | | | | | | Residential areas | | | | | | | | | Along the main roads | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Buses | | | Taxis | | | Pick-ups | | | Buses | | | Taxis | | | Pick-ups | | | Bus | | | Taxi | | | Pick-up | | |
| | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C |
| Muttrah | 12% | 48% | 40% | 68% | 30% | 2% | 39% | 55% | 6% | 3% | 27% | 70% | 39% | 43% | 18% | 14% | 51% | 35% | 33% | 53% | 14% | 67% | 31% | 2% | 58% | 38% | 4% |
| Boashar | 9% | 63% | 28% | 43% | 46% | 11% | 46% | 46% | 8% | 1% | 15% | 84% | 9% | 26% | 65% | 10% | 25% | 65% | 24% | 64% | 12% | 42% | 55% | 3% | 67% | 32% | 1% |
| Seeb | 3% | 87% | 10% | 41% | 58% | 1% | 80% | 17% | 3% | 1% | 29% | 70% | 10% | 36% | 54% | 26% | 39% | 35% | 23% | 62% | 15% | 43% | 56% | 1% | 88% | 11% | 1% |
| Al-Amarat | 12% | 55% | 33% | 58% | 36% | 6% | 45% | 48% | 7% | 6% | 33% | 61% | 15% | 36% | 49% | 24% | 36% | 40% | 30% | 59% | 11% | 48% | 39% | 12% | 64% | 33% | 3% |
| Muscat Area | 9% | 62% | 29% | 54% | 42% | 4% | 51% | 42% | 7% | 3% | 25% | 72% | 22% | 37% | 41% | 17% | 41% | 42% | 28% | 65% | 7% | 53% | 44% | 3% | 69% | 29% | 2% |
| Non-car-owners households | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Muscat Area | 9% | 59% | 32% | 59% | 39% | 2% | 51% | 40% | 9% | 2% | 31% | 67% | 37% | 42% | 21% | 19% | 48% | 33% | 29% | 58% | 13% | 69% | 30% | 1% | 71% | 23% | 5% |

Source Home Interview , Fieldwork Muscat 1990 missing, except for few popular routes where, by consensus, drivers normally charge standard fares.

The taxis provide ideal services to those who wish to travel individually or in group to a common destination. They offer a door-to-door service which cannot be achieved by public buses. In the Muscat Area, people use taxis more commonly for short distance travel, particularly during their movements between and to/from the commercial centres (Chapter 3). There is no system to organise the operation of taxis in Muscat. The drivers have the freedom to run their taxis wherever and whenever they wish. They do not operate in areas where they are unlikely to get passengers. The taxi service is adequate in the major commercial areas, around hospitals and government administrations, and along the main roads. Away from these areas the service is poor.

Taxi services are not centrally organised, and it is therefore not possible to order one. Anyone wishing to take a taxi must go to the main road, and this sometimes requires considerable walking and waiting, particularly, in poorly served areas such as Boashar municipality. However, taxis circulate all the time along main roads, causing unnecessary traffic congestion.

### *8.1.2 - PICK-UPS (shared taxis)*

The shared taxis in Oman are mostly owner driven Japanese double-cabin pick-ups which can be hired to carry goods and passengers. Pick-ups are registered under commercial vehicles, hence precise figures for those operating as shared taxis are not available. Passenger pick-up operations are uncontrolled in their current form and are contrary to article 21 of Traffic Ordinance[4]. The authorities in Muscat decided, by the end of 1996, to ban completely all passenger pick-ups from operating within the boundary of the capital area. Therefore, passenger pick-up owners are encouraged to replace their vehicles gradually by microbuses.

The new law does not specify the operation and the use of the new microbuses. It leaves the drivers free to run their vehicles on any route at the time they wish as in the case of the pick-ups. Despite the fact that microbuses can offer a more comfortable ride than the pick-up, their role and operation system are expected to be similar to those of the pickups to some extent. However, pick-ups have the advantage of serving passengers with access goods which cannot be carried by the buses. Compared to other modes of public transport (taxis & ONTC buses), pick-ups have the highest proportion of long trips. More than half of the trips made by pick-ups are either between the municipalities or to areas outside Muscat boundary. Pick-up flow accounts for more than 20 per cent of the total traffic crossing the Muscat Area boundary, (see chapters 3 & 4).

Pick-ups operate mainly along the regional roads and between the main commercial areas where the demand is high. They are more available along the highways than other types of public transport and perform a major role competing with the ONTC buses, making it impossible for the latter to operate on a cost-covering basis. Pick-ups are often observed violating traffic rules and regulations due to the continual stopping to pick up and set down passengers at random spots along the high speed highways - regardless of other road users. This practice is commonly considered to be the reason for most traffic accidents and congestion during the peak hours. This problem is equally valid for licensed taxis. However, as the taxis share a small proportion of the total flow along the regional roads, irregular driving habits of licensed taxis are less frequent.

### *8.1.3 - PUBLIC BUS SYSTEM*

Public bus services in Oman are provided by the Oman National Transport Company (ONTC). The company was established in 1974 and began operation in 1975. It was formed as a private company, with the equity shared between the government and private sectors. In 1979, the government bought all the shares of ONTC due to the financial difficulties which prevented the company from providing sufficient public bus services[5]. Since then, the bus operation has been supervised by the Ministry of Communications.

The bus company has the responsibility of providing public bus services generally throughout the country and, because the company successfully acquired a significant proportion of profitable contract and charter operations, it was able to balance its losses in operating its limited network of public bus services. At present, the company operates 9 scheduled bus routes and 2 routes during the weekends in the Muscat Area (see *table 8.2 & figure 8.1*). The company also operates 11 bus routes from the Muscat Area to other parts of the country and one international route between Muscat and Dubai. Besides these, ONTC provides 141 contract carriages for ministries and other major private sectors[6]. It also offers special transport services, (e.g. transporting of the pilgrims to Saudi Arabia during the period of Hajj).

The operated vehicle fleet size was 262 vehicles in 1990, of which 99 buses were not air-conditioned and 163 vehicles were air-conditioned. In the non-air-conditioned fleet, large buses account for 47 buses, and the mini and midi total 52 buses. In the air-conditioned fleet, large buses and coaches account for 64 vehicles, mini and midi buses 66, whilst the remaining 33 are shared between various types of vehicles. As for the peak vehicle demand, the bus routes in the Muscat area demand 29 buses, the routes in the rest of the country demand 32 buses and the international route 2 coaches, whilst 141 buses are provided for the contract services. However, the operating buses in the Muscat Area are not-air-conditioned. At the weekends, when some air-conditioned buses are not allocated to contract services, they are substituted for non-air-conditioned ones on selected long distance routes in the Muscat Area.

Despite the increase in the population of the Muscat Area since the ONTC buses were introduced, the number of bus riders has not witnessed any significant change to reflect the increase in the population. According to the ONTC, the total number

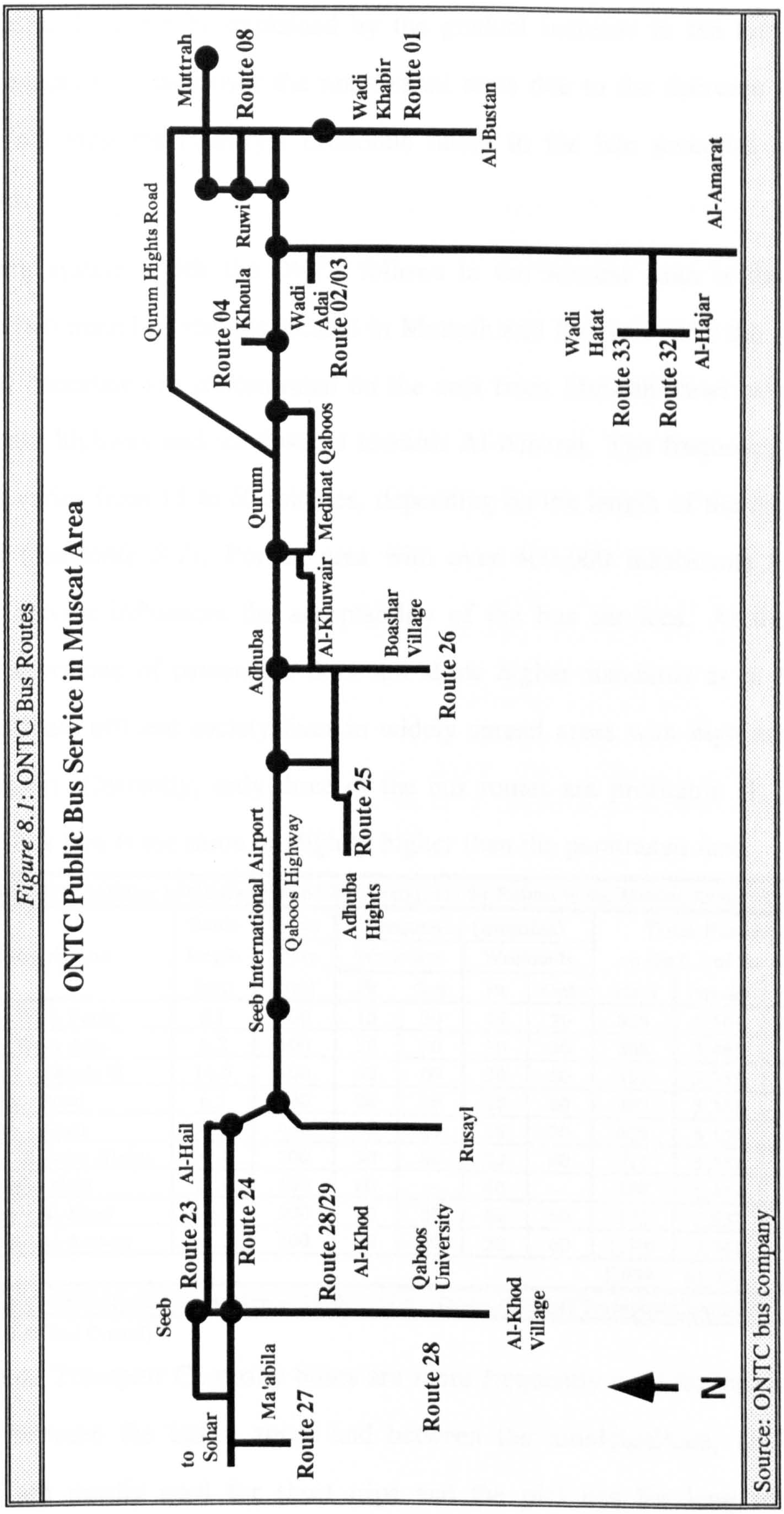


*Figure 8.1*: ONTC Bus Routes

of bus passengers in Muscat Area was roughly uniform with signs of improvement in recent years. This can be explained by the gradual increase in the number of Omani passengers who take over the non-Omani seats due to the decrease in their population following the country's economic boom in the late seventies and the early eighties.

The operating system which the ONTC follows in the Muscat Area is the radial pattern with two main bus stations located in Muttrah and Ruwi to serve the system. The areas of operation are concentrated on the area from Muttrah/Ruwi westwards along the main highway and southwards towards Al-Amarat. The frequency of the bus services varies from 15 to 60 minutes, depending on the length of the route and the demand (see *table 8.2*). For an area with over 400,000 inhabitants the low standard of service influences the acceptability of the bus services. At the same time, the low volume of passengers does not allow higher standards as in Muscat where a relatively affluent society lives in widely spread areas with high access to private transport. Currently, only three of the bus routes are profitable (1, 3, and 31/32). The bus fare is the same or slightly higher than the paratransit fare.

*Table 8.2* : Number of Passengers and Bus Frequency by Routes in the Muscat Area

| Route No. | Description | Route length (km) | direct Fare (bz ) | Frequency (minutes) Weekdays Pk | Weekdays Opk | Weekends Pk | Weekends Opk | Total Passengers on the ( ) of the Survey (day) | (week) | (month) |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Ruwi - Wadi Kabir | 6.1 | 100 | 15 | 30 | 15 | 20 | 825 | 5,501 | 26,091 |
| 03 | Ruwi - Wadi Adai | 6.2 | 100 | 30 | 30 | 30 | 30 | 500 | 3,485 | 15,993 |
| 04 | Muttrah - Khoula H. | 14.5 | 100 | 30 | 60 | 30 | 60 | 591 | 3,753 | 16,856 |
| 08 | Muttrah - Ruwi | 6.1 | 100 | 20 | 20 | 20 | 60 | 467 | 3,386 | 15,235 |
| 23/24 | Muttrah - Seeb | 57.0 | 400 | 30 | 60 | 15 | 30 | 979 | 8,159 | 41,617 |
| 25 | Ruwi - Adhuba Hights | 31.0 | 200 | 30 | 60 | 20 | 60 | 711 | 5,559 | 28,622 |
| 27 | Seeb - Ma' abila | 11.0 | 100 | 60 | -- | 60 | -- | 189 | 1,414 | 6,021 |
| 28 | Muttrah - Al-Khod | 60.3 | 500 | 60 | 60 | 60 | 60 | 371 | 2,532 | 12,435 |
| 31/32 | Muttrah - Al-Amarat | 33.2 | 200 | 20 | 60 | 20 | 60 | 1,306 | 7,961 | 40,022 |
| Total | | | | | | | | 5,939 | 41,750 | 202.892 |

Source: Passenger Interview, Fieldwork Muscat 1990 Oman National Transport Company

bz = biazc (1/1000 Rail Omani)

Oman National Transport Company buses are more frequently used during people's movements between the traffic zones and between the municipalities, unlike the taxis which are mostly used for short trips and the pick-ups for long trips. At present, there are about 3.2 million annual passenger journeys of which the bus routes in Muscat Area account for 46 per cent. The international route accounts for only 0.4 per cent, and the remaining bus routes in the whole country account for 12 per cent. Contract carriages share 41.6 per cent of the total passenger journeys.

## 8.2 - BUS TRANSPORT: IMPROVEMENT PROBLEMS

Development planning in the Muscat Area has favoured the interest of the car-owning population. The underlying assumption was that in an area with relatively low density population and high level of car ownership, public transport is less important, particularly the conventional buses. Therefore, in order to provide more access to private transport, roads and intersections were built to whatever standards to provide free-flow conditions. This policy tended to exacerbate the problems of traffic congestion and environmental degradation. Barat (1985) says:

> Private transport has been encourage not only by socio-economic development and shortcomings in transit services, but also by generous investment policies aimed at relieving urban congestion. However, the construction of elevated roads, expressways, beltways and parking facilities has proven to be a two-edged weapon which temporarily eased flows but simultaneously attracted more vehicles. These soon required additional space in the urban areas and the central business districts, thus creating new traffic bottlenecks and parking problems[(7)].

The private car is the most common mode of transport used in the Muscat Area. Thus, it is considered the major competitor for the public bus transport company. Car travel has not only the advantage of being flexible and increases mobility, but also stimulates the development of low density residential areas with unstructured travel demands, resulting in substantial reductions in the role of and effectiveness of public transport. Furthermore, people in Muscat are discouraged from using buses by a perception of bad aspects such as having to wait in the hot weather, slow journey, and an uncomfortable ride. Therefore, any attempts to reverse these trends towards the use of public transport might not be easy, particularly, in an environment where the activity patterns and urban structure depend on very high levels of individual mobility[(8)].

Potential competition with paratransit is also a factor that plays a major role in restricting the improvement of bus services. In a letter of complaint to the Directorate General of Traffic (1991) the writer says:

> Nowadays the taxis and the pick-ups crowd in the bus stops, thereby preventing people from boarding the buses they have been waiting for. I get very disappointed when a long-distance-bus appears but taxis and pick-ups crowd in the bus stop forcing the bus to skip the stop and I miss the bus for which I have been waiting a very long time[9].

The strength of paratransit, particularly the pick-ups, lie in the high accessibility which they offer to the potential users at a low fare. They are popular with the low-income population particularly Asian expatriates. On the main roads, pick-ups are almost continuously available throughout much of the day. Because pick-ups stop anywhere on the roadside, they have a much higher level of convenience to the potential users than public buses which have a limited number of stops. This situation is further exacerbated by the current Labour Laws in which the employer is obliged to provide transport for his staff between home and work. Consequently, firms and some ministries operate mini-bus fleets which can provide almost a door-to-door flexible service for the journey to work and home, against which ONTC finds it difficult to compete economically.

Some of the commuters who work in the Muscat Area use collective private transport. A group of car-owners who come from the outskirts to work in Muscat agree to use their private vehicles in turn. This is also another factor affecting the improvement of public bus transport, particularly in terms of bus routes and frequency to the areas outside Muscat.

However, in common with many public transport companies around the world, the ONTC finds it difficult to meet its costs through fare income and to provide a reasonable level of service in the face of the low demand and the high cost. The majority of the public bus services are unprofitable and many such services, including most in the Muscat Area, do not even meet their direct incremental cash cost. The company is not able to meet its working capital needs in spite of the profitable express services, and contracts and charters operations(10).

## 8.3 - EVALUATION OF PUBLIC BUS TRANSPORT

### *8.3.1 - INTRODUCTION*

The public bus transport service is an integral element of the public transport, therefore, its evaluation could be combined with the analysis of all components of the public transport system. The researcher's resources and time-scale were limited to statistically demonstrate the condition of all forms of public transport. However, the importance of taxis and pickups to Muscat is evident. At present, the bus-system comes in the final position after the taxis and pickups in terms of their importance for the potential users of public transport. Therefore, it is necessary to focus on the bus transport service in order to improve its role within the public transport system.

### *8.3.2 - PATTERN OF BUS PASSENGERS*

*Table 8.3* shows the pattern of bus passengers in terms of their sex and nationality. Non-Omanis constitute nearly 65 per cent of the total bus riders in the Muscat Area despite the fact that they represent only 35 per cent of the total population. Omani passengers form only 35 per cent and this reflects the low demand for public transport among the Omanis due to their higher income which results in increased car ownership. In both nationalities, female passengers account for a low but significant proportion of the total passengers. This is due to the fact that public transport does not play a significant part in the movement of females in the Muscat Area (Chapter 3). However, females consider ONTC buses much safer than other modes of public transport and there may be a high potential for female passengers if the bus service is improved.

About 6.5 per cent of the total passengers interviewed were car-owners, of which 91 per cent were Omani. When the car-owners were investigated in terms of the reason for using ONTC buses, 60 per cent stated that their cars were being used by someone else, for 29 per cent the car was under repair, for 9 per cent a car was not available in the Muscat Area and only 2 per cent considered the bus service cheaper.

| *Table 8.3*: Number of Passengers per Route by Nationality and Sex | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Route | Omani | | | | Non-Omani | | | | Total Passengers | |
| | Male | | Female | | Male | | Female | | | |
| No. | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| (1) | 60 | 4.5% | 7 | 0.3% | 229 | 10.4% | 6 | 0.3% | 302 | 13.7% |
| (3) | 121 | 5.5% | 15 | 0.7% | 178 | 8.1% | 3 | 0.1% | 317 | 14.4% |
| (4) | 62 | 2.8% | 26 | 1.2% | 108 | 4.9% | 9 | 0.4% | 205 | 9.3% |
| (8) | 81 | 3.8% | 5 | 0.2% | 187 | 8.1% | 7 | 0.3% | 280 | 12.7% |
| (23/24) | 56 | 2.5% | 6 | 0.3% | 178 | 8.1% | 3 | 0.1% | 243 | 11.0% |
| (25) | 11 | 0.5% | 4 | 0.2% | 223 | 10.2% | 22 | 1.0% | 260 | 11.8% |
| (27) | 76 | 3.4% | 63 | 2.9% | 50 | 2.4% | 0 | 0.0% | 189 | 8.6% |
| (28) | 50 | 2.3% | 3 | 0.1% | 92 | 4.3% | 2 | 0.1% | 147 | 6.7% |
| (31/32) | 93 | 4.2% | 44 | 2.0% | 118 | 5.4% | 4 | 0.2% | 259 | 11.8% |
| Total | 610 | 27.7% | 173 | 7.9% | 1363 | 61.9% | 56 | 2.5% | 2202 | 100% |
| Source: Passenger Interview, Fieldwork Muscat 1990 (( passenger counts )) | | | | | | | | | | |

*Table 8.4* shows the employment status of bus passengers in terms of age, sex and nationality. Privately employed people are the majority of bus passengers; they account for more than half of the total passengers. This high proportion of privately employed passengers reflects the high demand for public transport among the low-income population, particularly Asian labourers (generally, payment in the private sector is much less than in the government). Government employed people make up 22 per cent of the total passengers and the Omanis account for the higher proportion. Most of the students and unemployed passengers are Omanis and account for 8 per cent and 10 per cent respectively. Unemployed passengers, Omani females (housewives) are the majority particularly these from 18 to 65 years of age.

### *8.3.3 - TRAVEL FREQUENCY OF BUS PASSENGERS*

In order to explore the frequency of travel of bus passengers, passengers were asked how often they travelled on ONTC buses. If the answer was frequently, then they were asked to state the average number of trips per week. Out of the 884 passengers only 233 persons (26%) used the buses frequently. This proportion reflects the irregularity of nearly three-quarters of the total passengers. In terms of the number of trips, the group with 6 to 10 trips per week emerges as the highest in both Omani and non-Omani, (*table 8.5*).

*Table 8.4:* Pattern of Bus Passengers

| Occupation | Omani Male Under 18 | Omani Male 18 to 39 | Omani Male 40 to 65 | Omani Male Over 65 | Omani Female Under 18 | Omani Female 18 to 39 | Omani Female 40 to 65 | Omani Female Over 65 | Total Oman | Non-Omani Male Under 18 | Non-Omani Male 18 to 39 | Non-Omani Male 40 to 65 | Non-Omani Male Over 65 | Non-Omani Female Under 18 | Non-Omani Female 18to 39 | Non-Omani Female 40 to 65 | Non-Omani Female Over 65 | Total Non-Omani | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Student | 52 | 17 | 0 | 0 | 2 | 2 | 0 | 0 | 73 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 74 |
| Govt Employed | 5 | 67 | 37 | 1 | 1 | 2 | 0 | 0 | 113 | 1 | 51 | 19 | 1 | 0 | 5 | 1 | 0 | 78 | 191 |
| Privately Emp. | 6 | 56 | 32 | 0 | 3 | 1 | 0 | 0 | 98 | 0 | 298 | 51 | 3 | 0 | 5 | 1 | 0 | 358 | 453 |
| Self Employed | 0 | 6 | 9 | 2 | 0 | 0 | 1 | 0 | 18 | 0 | 35 | 19 | 0 | 0 | 0 | 0 | 0 | 54 | 72 |
| Unemployed | 5 | 8 | 26 | 2 | 0 | 21 | 20 | 0 | 82 | 0 | 4 | 0 | 0 | 0 | 4 | 1 | 0 | 9 | 52 |
| Total | 68 | 154 | 104 | 5 | 3 | 27 | 23 | 0 | 384 | 2 | 388 | 89 | 4 | 0 | 14 | 3 | 0 | 500 | 884 |

Source: Passenger Interview Survey, Fieldwork Muscat 1990

*Table 8.5* :Frequency of Bus Passengers Travel

| Description | Omani Male Under 18 | Omani Male 18 to 39 | Omani Male 40 to 65 | Omani Male Over 65 | Omani Female Under 18 | Omani Female 18 to 39 | Omani Female 40 to 65 | Omani Female Over 65 | Total Oman | Non-Omani Male Under 18 | Non-Omani Male 18 to 39 | Non-Omani Male 40 to 65 | Non-Omani Male Over 65 | Non-Omani Female Under 18 | Non-Omani Female 18to 39 | Non-Omani Female 40 to 65 | Non-Omani Female Over 65 | Total Non-Omani | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Travelling regularly: number of trips per week | | | | | | | | | | | | | | | | | | | |
| 1 to 5 trips | 2 | 10 | 12 | 0 | 0 | 1 | 2 | 0 | 27 | 0 | 25 | 6 | 0 | 0 | 0 | 0 | 0 | 31 | 58 |
| 6 to 10 trips | 1 | 8 | 15 | 1 | 0 | 1 | 2 | 0 | 28 | 1 | 63 | 8 | 1 | 0 | 2 | 0 | 0 | 75 | 103 |
| 11 to 15 trips | 1 | 7 | 5 | 1 | 1 | 2 | 0 | 0 | 17 | 0 | 27 | 5 | 0 | 0 | 1 | 0 | 0 | 33 | 50 |
| 16 to 20 trips | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 11 |
| Over 20 trips | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 8 | 11 |
| Sub-total | 6 | 30 | 33 | 2 | 1 | 4 | 5 | 0 | 81 | 1 | 126 | 21 | 1 | 0 | 3 | 0 | 0 | 152 | 233 |
| Travelling occasionally | | | | | | | | | | | | | | | | | | | |
| This week | 24 | 41 | 16 | 1 | 1 | 7 | 5 | 0 | 95 | 0 | 103 | 28 | 1 | 0 | 4 | 1 | 0 | 137 | 232 |
| Last week | 24 | 55 | 32 | 1 | 1 | 8 | 7 | 0 | 128 | 0 | 91 | 24 | 2 | 0 | 6 | 1 | 0 | 124 | 252 |
| Long time ago | 14 | 28 | 23 | 1 | 0 | 8 | 6 | 0 | 80 | 1 | 68 | 16 | 0 | 0 | 1 | 1 | 0 | 87 | 167 |
| Total | 62 | 124 | 71 | 3 | 2 | 23 | 18 | 0 | 303 | 1 | 262 | 68 | 3 | 0 | 11 | 3 | 0 | 348 | 651 |
| Total | 68 | 154 | 104 | 5 | 3 | 27 | 23 | 0 | 384 | 2 | 388 | 89 | 4 | 0 | 14 | 3 | 0 | 500 | 884 |

Source: Passenger Interview Survey, Fieldwork Muscat 1990

Considering the passengers who travel occasionally, about 36 per cent used ONTC buses during the week of the survey, 39 per cent the week before and 25 per cent long time ago. Splitting the passengers into Omani and non-Omani, no significant variation is detected. When male and female passengers are separated, similar proportions are found.

### *8.3.4 - PASSENGER MOVEMENTS*

*table 8.6* shows the geographical distribution of bus passengers in terms of origin and destination in the Muscat Area. Evidently Muttrah municipality accounts for the majority of bus passenger movements. About 71 per cent of total bus passenger trips have at least one end within the municipality and more than 55 per cent are made entirely within this municipality. Al-Amarat has the lowest proportion of passenger movements. Only 4 per cent of the trips have one end within this municipality, while trips having both ends within it account for less than one per cent. Trips with one end outside the Muscat Area account for less than one per cent (4 trips) of total passenger trips. These results are consistent with personal travel in Chapter 3, reflecting the distribution of Muscat population and the concentration of bus services.

*Table 8.6*: Pattern of Bus Passengers Movements

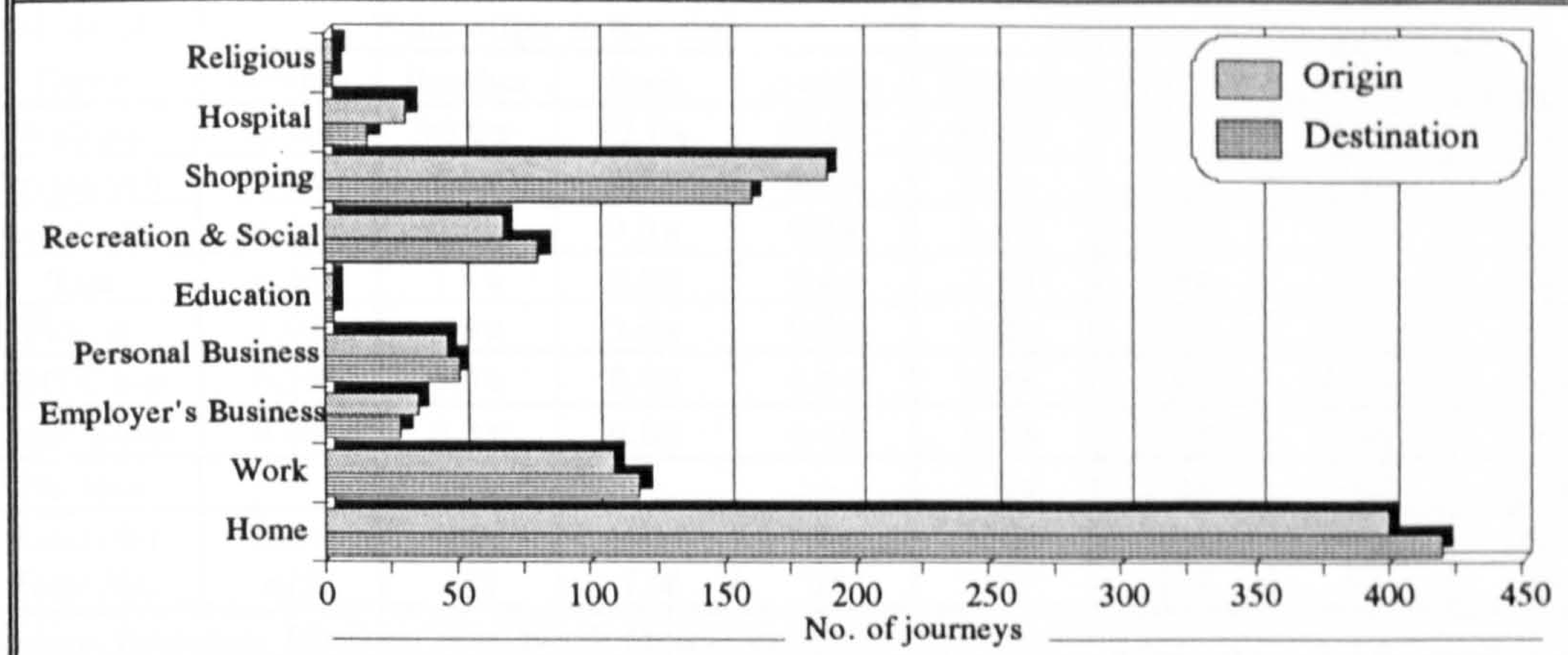
| Origin | <--------- Destination Area -----------> | | | | |
|---|---|---|---|---|---|
| Area | Muttrah | Boashar | Seeb | Amarat | Total trips |
| Muttrah | 487 | 82 | 16 | 34 | 619 |
| Boashar | 99 | 20 | 0 | 3 | 122 |
| Seeb | 29 | 7 | 78 | 0 | 114 |
| Amarat | 22 | 0 | 0 | 3 | 25 |
| Total trips | 637 | 109 | 94 | 40 | 880 |

Source: Passenger Interview, Fieldwork Muscat 1990

### *8.3.5 - THE PURPOSES OF BUS JOURNEYS*

A high proportion of passengers trips are made to travel to/from home. About 45 per cent of the total passenger trips start from home and nearly 48 per cent end there. This demonstrates the role of bus-stop locations to home in increasing the number of bus passengers. People in Muscat use the bus more when they travel to the shopping areas. The use of public bus transport for shopping purposes accounts for 20 per cent, showing that the bus service is quite adequate in the major shopping areas.

*Figure 8.2*: Origin and Destination Purposes of Bus Passengers




Source: Passenger Interview, Fieldwork Muscat 1990

*Figure 8.2* shows that people more frequently use ONTC buses to travel from the shopping area than to get there. Work trips make up 13 per cent of all bus passenger trips and most of them are made by people working in Muttrah and Ruwi commercial areas. The low proportion of education trips is due to the fact that the survey was carried out during the summer vacation.

### *8.3.6 - MODE OF TRAVEL FROM AND TO THE BUS-STOP*

The purpose of this section is to demonstrate modes of transport used to and from the bus-stops in order explore the percentage of passengers who have to use another mode of transport during their journey. *Table 8.7* shows the modes of travel used to/from the bus-stop by municipality. Over 90 per cent of all passenger trips made are on foot. Walking distance to the bus-stop in Muttrah is shorter than in the other municipalities, reflecting the concentration of bus services in this municipality. Private vehicles are the dominant motorised mode of travel from the trip origin to the bus-stop in all municipalities. For people who had to use other modes of travel to reach their destination within Muttrah municipality 3.6 per cent anticipated that they would use taxis, 2.8 per cent ONTC buses and 1.2 per cent had no idea what mode of transport to use to reach their destination. In Boashar and Seeb, pick-ups seem to be more available, therefore most of the bus riders use the pick-up in order to reach their destination. It is clear that ONTC buses do not provide a sufficient connection system.

*Table 8.7*: Mode of Travel Used from and to the Bus-stop

| Mode of Travel | From origin to bus-stop | | | | From bus-stop to destination | | | |
|---|---|---|---|---|---|---|---|---|
| | Muttrah | Boashar | Seeb | Amarat | Muttrah | Boashar | Seeb | Amarat |
| Walking | 95.0% | 90.0% | 92.6% | 92.0% | 90.6% | 94.5% | 92.6% | 90.0% |
| Private veh. | 2.0% | 5.5% | 3.5% | 8.0% | 0.5% | 0.9% | 0.0% | 2.5% |
| Good veh. | 1.0% | 0.0% | 0.9% | 0.0% | 0.3% | 0.0% | 1.1% | 0.0% |
| Taxi | 0.3% | 1.9% | 0.0% | 0.0% | 3.6% | 0.0% | 1.1% | 0.5% |
| Pick-up | 1.0% | 1.6% | 3.0% | 0.0% | 0.8% | 0.9% | 4.2% | 2.0% |
| ONTC bus | 0.3% | 1.0% | 0.0% | 0.0% | 2.8% | 0.9% | 0.0% | 0.0% |
| Other Buses | 0.4% | 0.0% | 0.0% | 0.0% | 0.2% | 0.0% | 0.0% | 0.0% |
| No idea | --- | --- | --- | --- | 1.2% | 2.8% | 1.0% | 5.0% |
| Total (%) | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| *Total No.* | *619* | *122* | *114* | *25* | *637* | *109* | *94* | *40* |

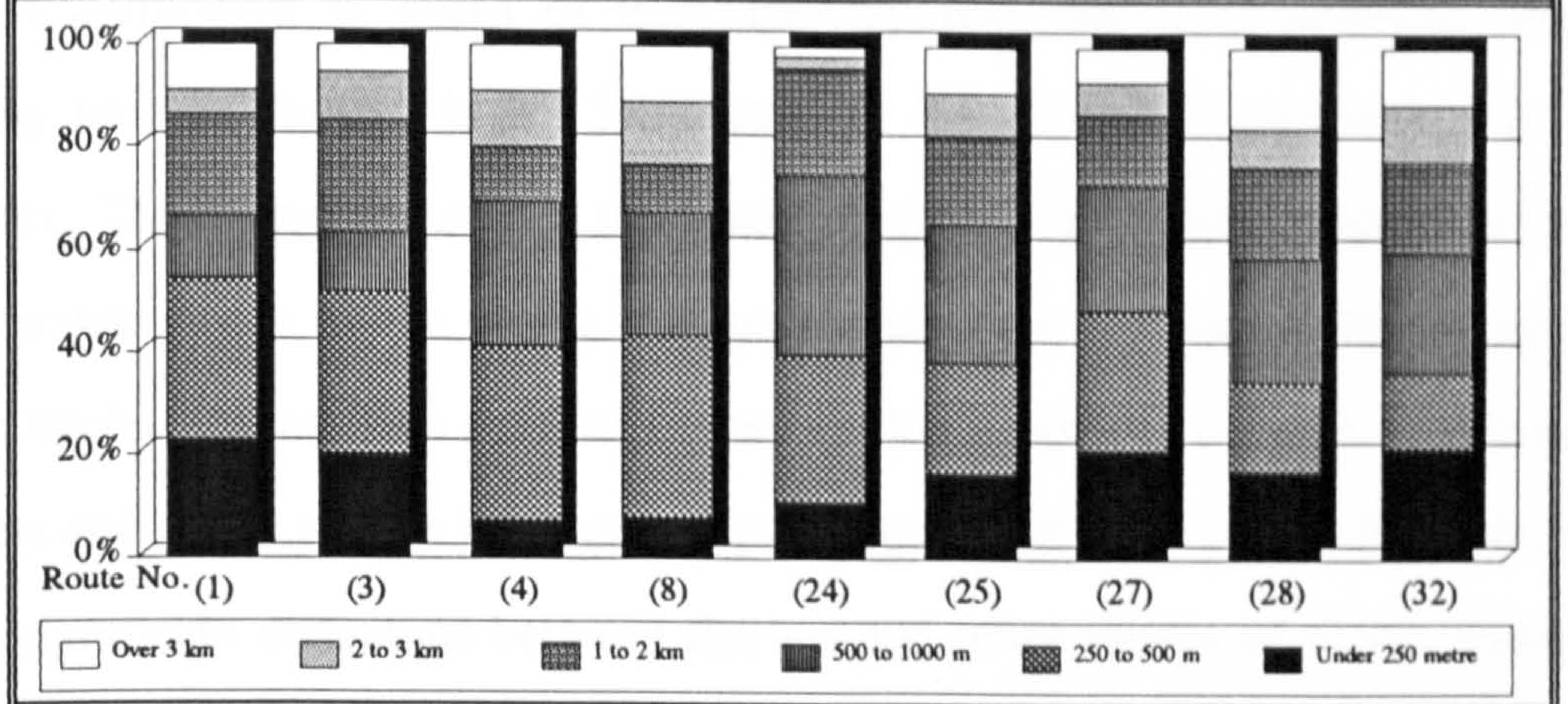
Source: Passenger Interview, Fieldwork Muscat 1990

### *8.3.7 - DISTANCE TO AND FROM THE BUS-STOP*

Convenient bus stop locations and frequency generally have a considerable effect on the public's decision to use public bus transport. *Figure 8.3* illustrates the proportions of the average distances passengers travel to/from the bus-stops for the scheduled bus routes in the Muscat Area. The common distance to travel to/from bus-stops in routes number 1, 3, 4, 8 and 27 is 250 to 500 metres, and in the remaining routes it is 500 to 1,000 metres. The former first 4 routes operate mostly within Muttrah municipality where built-up areas are determined by the mountainous terrain with relatively high density development at various bays and valleys which do not permit long distance travel, in addition to the concentration of ONTC services. Route 27 is short. It connects Ma'abila residential area with Seeb town shopping centre and provides a direct link between the shopping centre and home. The remaining routes (24, 25, 28 & 32) are long and link the major settlement areas with the commercial areas in Greater Muttrah. They operate along the main roads through low density areas which permit long distance travel to the bus-stop.

A high proportion of people travel long distance to the bus-stops or to their destination. This means that the distribution of bus-stops or the bus service is not adequate. Therefore, bus-stop location must be considered where necessary within a reasonable walking distance.

*Figure 8.3*: Average Distance to and from the Bus-stop per Route




Source: Passenger Interview, Fieldwork Muscat 1990

## *8.3.8 - TRAVEL TIME TO AND FROM THE BUS-STOP*

The purpose of this section is to focus on the time taken to/from bus stops in municipal levels, as shown in *Table 8.8*. The most common time of travel to the bus-stop is the 5 to 10 minute, forming the highest proportion in all municipalities. It is also the highest proportion in case of movement from the bus-stops to the journey destination. As expected, in Muttrah travel to/from the bus-stop takes less time, followed by Al-Amarat, whilst in Boashar it requires more time than the other municipalities.

*Table 8.8*: Times of Travel to and from the Bust-stop

| Time | From origin to bus-stop | | | | From bus-stop to destination | | | |
|---|---|---|---|---|---|---|---|---|
| Minutes | Muttrah | Boashar | Seeb | Amarat | Muttrah | Boashar | Seeb | Amarat |
| Under 5 mi | 33% | 16% | 31% | 34% | 35% | 16% | 33% | 32% |
| 5 to 10 min | 40% | 40% | 35% | 36% | 43% | 35% | 34% | 44% |
| 10 to 15 mi | 22% | 31% | 19% | 21% | 16% | 36% | 26% | 16% |
| 15 to 20 mi | 4% | 8% | 11% | 3% | 5% | 9% | 6% | 3% |
| Over 20 mi | 1% | 4% | 4% | 6% | 1% | 4% | 1% | 5% |
| Total (%) | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| *Total No.* | *619* | *122* | *114* | *25* | *637* | *109* | *94* | *40* |

Source: Passenger Interview, Fieldwork Muscat 1990

## *8.3.9 - DURATION OF WAITING TIME AT THE BUS-STOP*

*Table 8.9* shows the waiting time for the bus in the four municipalities. Generally, the waiting time for the bus in the time categories 0 - 5 minutes and 6 - 10 minutes constituted 38 per cent and 40 per cent respectively. When the waiting time at a bus stop is considered in terms of each municipality, the most common length of waiting time in Muttrah is 0 - 5 minutes. In the other municipalities it is 6 - 10 minutes. The reason for such a short waiting time is the high competition between the various modes of the public transport where the demand is high, particularly along the bus routes. This resulted in the fact that people do not wait a long time for the bus and prefer to take the mode of public transport what comes first, since there is no significant difference between the bus and other modes of public transport in terms of the fare structure and service.

Of the 884 bus passengers interviewed, only 316 persons previously planned to use the ONTC buses at beginning of their journey, 31 persons planned to use taxis, 49 persons to use pick-up and 486 persons whichever would come first. It seems that people prefer to use the available mode of public transport due to the hot weather and the unreliability of public transport generally. However, it is evident from *table 8.9* that the passengers who boarded the buses in Muttrah waited less time than others who boarded the buses in the other municipalities, this is again confirming the concentration of the bus service with reasonable frequencies in this municipality.

*Table 8.9*: Waiting Times at the Bus-stop

| Time in Minutes | G. Muttrah | | Boashar | | Seeb | | Al-Amarat | |
|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| Up to 5 min | 255 | 41% | 32 | 26% | 39 | 34% | 8 | 32% |
| 6 to 10 min | 241 | 39% | 54 | 44% | 51 | 45% | 11 | 44% |
| 11 to 15 mi | 89 | 14% | 22 | 18% | 15 | 13% | 4 | 16% |
| 16 to 20 mi | 20 | 3% | 6 | 6% | 7 | 6% | 2 | 8% |
| 21 to 30 mi | 10 | 2% | 7 | 6% | 1 | 1% | 0 | 0% |
| Over 30 mi | 4 | 1% | 1 | 1% | 1 | 1% | 0 | 0% |
| Total | 619 | 100% | 122 | 100% | 114 | 100% | 25 | 100% |

Source: Passenger Interview, Fieldwork Muscat 1990

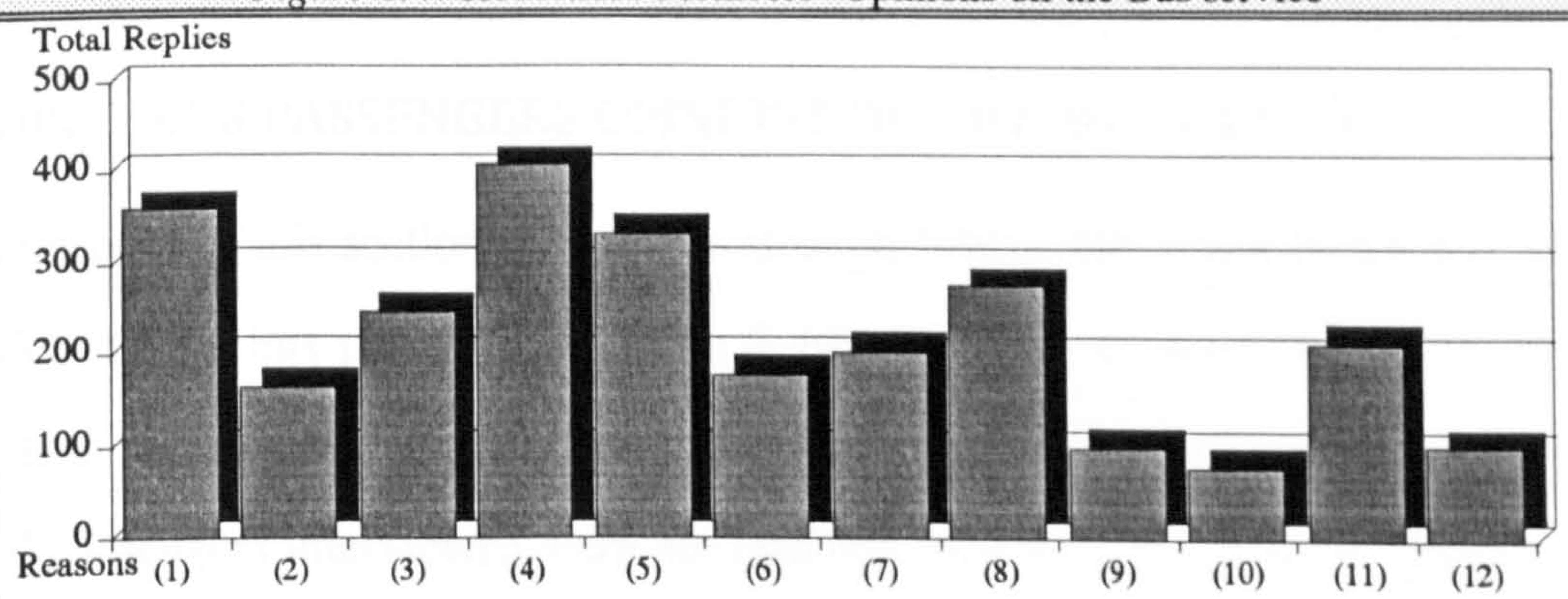
### *8.3.10 - PUBLIC OPINION ON THE BUS TRANSPORT*

This section explores public opinions regarding the public bus transport services. It attempts to identify the problems that face the potential users and discourages many people from using ONTC buses in the Muscat Area. It was necessary to collect a comprehensive data to ensure that information is obtained from various groups of people through a public opinion survey.

#### 8.3.10.1 - HOUSEHOLD MEMBERS' OPINIONS ON THE BUS SERVICE

The household members were requested to give their reasons for not using ONTC buses as an alternative mode of transport. The distance to the bus-stop is the main reason for not using the bus services followed by the reason that the car is more available and comfortable. The lack of air-conditioning in the pubic buses is the third important factor discouraging people from using the service. The most significant problem connected with the bus-stops is the lack of shelter (despite their locations), which is the fourth important factor. The lack of shelter could be an important factor discouraging people from waiting for buses in the heat of the day and causes them to seek another form of transport, thereby affecting the company's revenue. The unreliability of the bus service and the convenience of other forms of public transport (taxis) are other important limiting factors in the using of ONTC buses (see *figure 8.4*).

*Figure 8.4*: Household Members' Opinions on the Bus service




1) -Car available & comfortable
2) - The service not familiar
3) - Bus service not reliable
4) - Bus-stop too far away
5) - Buses not air-conditioned
6) - Journey time too long
7) - Inadequate bus frequency
8) - Poor bus-stop facilities
9) - Bus fares too high
10) - Insufficient luggage capacity
11) - Taxis more convenience
12) - Private transport provided

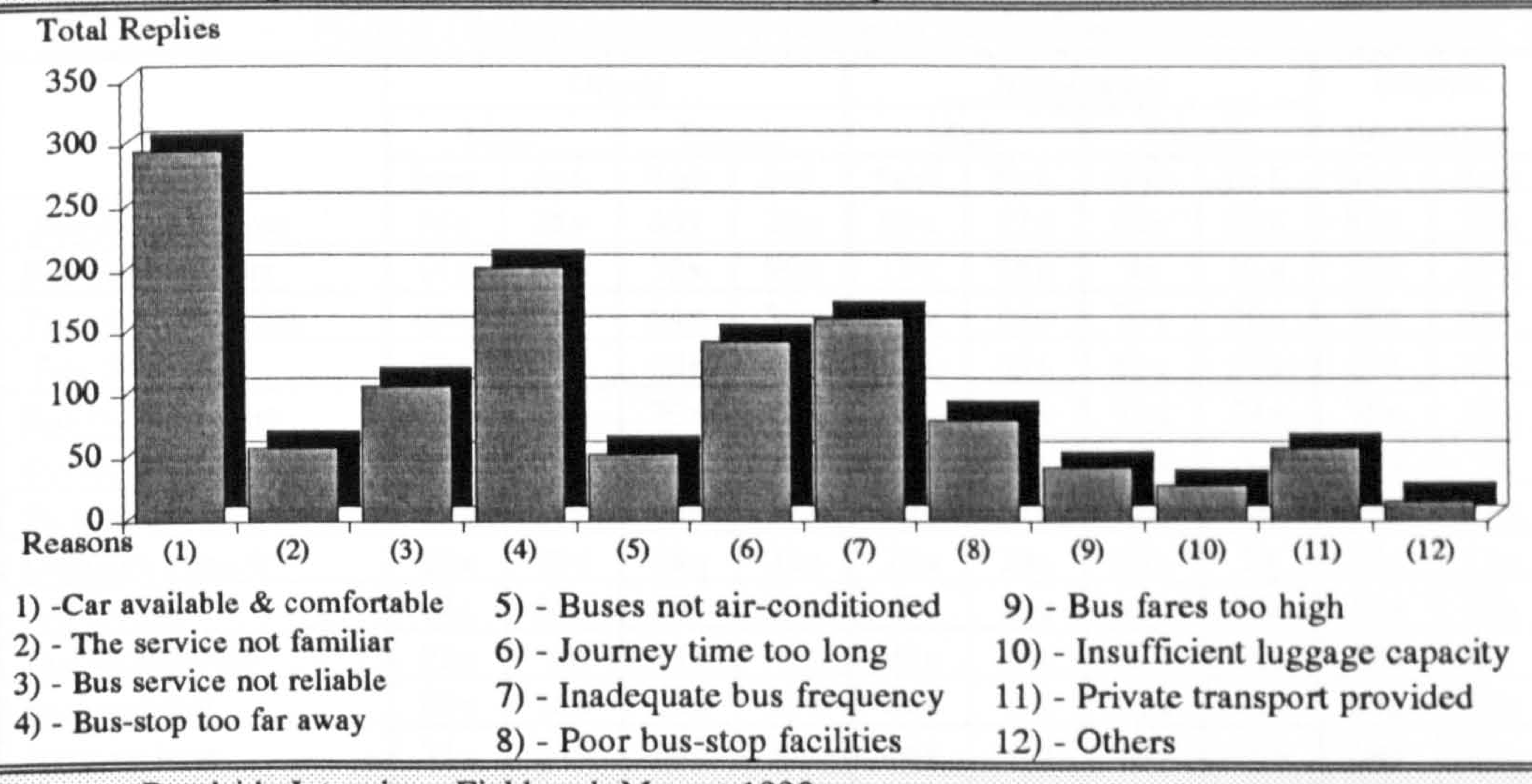
Source: Home Interview, Fieldwork Muscat 1990

## 8.3.10.2 - PRIVATE VEHICLE DRIVERS' OPINIONS ON THE BUS SERVICE

Private vehicle drivers were requested to give their reasons for not using ONTC buses during their journey into the Muscat Area. Unlike the household members, vehicle drivers see the availability of private transport and its comfort as the most important reason for not using the bus. The lack of convenient bus-stop location, inadequate bus frequency, length of the journey, the unreliability of the bus service, and poor bus-stops facilities are other discouraging factors (see *figure 8.5*).

When the private vehicle drivers were asked whether they would be prepared to use ONTC buses, if the quality of services were improved, 43 per cent of the drivers were willing to use the buses. The remaining were unwilling to use ONTC buses even if the service quality was improved.

*Figure 8.5*: Private Vehicle drivers' Opinions on the Bus Service




Source: Roadside Interview, Fieldwork Muscat 1990

## 8.3.10.3 - BUS PASSENGERS OPINIONS ON THE BUS SERVICE

The purpose of this section is to give a clear picture of the image of the bus services in view of the bus passengers, (*Table 8.10*). The lack of air-condition facilities is the most significant complaint connected with use of the ONTC buses; 90 per cent of all passengers interviewed were not satisfied with the air-condition facilities. This is due to the fact that all the buses on the scheduled routes in the Muscat Area are not air-conditioned. Providing air-conditioned buses could be a significant factor in attracting more people, particularly in the hot weather, where such a service might not be cost-effective for the other forms of public transport. The other important problem relating to the hot weather is the lack of shelter, which is the complaint of 89 per cent of the passengers. The lack of connecting services, on the occasion when a passenger wishes to make a journey involving a change of buses, is another factor according to 83 per cent of the passengers interviewed.

Complaint such as the distance to the bus-stops from home or to destination, bus frequency, tariff, time scheduled and travel information are worth consideration. The lack of information discourages occasional travellers from using buses. When the passengers opinions are seen in terms of nationality and sex, there are no significant variations and each individual group opinion is consistent with the overall opinion.

*Table 8.10:* Bus passengers' opinions on the bus service

| Reasons | Omani | | | | Non-Omani | | | | Overall percentage | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | Female | | Male | | Female | | | |
| | Satisfy | Not S. | Satisfy | Not S. | Satisfy | Not S. | Satisfy | Not S. | Satisfy | Not S. |
| Bus-stop at home | 65% | 35% | 80% | 20% | 63% | 37% | 65% | 35% | 65% | 35% |
| Bus-stop shelters | 11% | 89% | 10% | 90% | 12% | 88% | 9% | 91% | 11% | 89% |
| Travel information | 69% | 31% | 64% | 33% | 78% | 22% | 70% | 30% | 74% | 26% |
| Bus frequency | 56% | 44% | 60% | 40% | 57% | 43% | 61% | 39% | 57% | 43% |
| Bus runs on time | 72% | 28% | 76% | 24% | 83% | 17% | 76% | 24% | 78% | 22% |
| Driver's attitude | 95% | 5% | 96% | 4% | 91% | 9% | 95% | 5% | 95% | 5% |
| Fare rate | 81% | 19% | 78% | 22% | 69% | 31% | 70% | 30% | 71% | 29% |
| Luggage capacity | 80% | 20% | 68% | 32% | 76% | 24% | 95% | 5% | 77% | 23% |
| AC facility | 14% | 86% | 10% | 90% | 8% | 92% | 6% | 94% | 10% | 90% |
| Bus cleanliness | 92% | 8% | 94% | 6% | 93% | 7% | 82% | 18% | 93% | 7% |
| Seat comfort | 82% | 18% | 73% | 27% | 81% | 19% | 82% | 18% | 80% | 20% |
| Journey time | 73% | 27% | 68% | 32% | 64% | 33% | 70% | 30% | 69% | 31% |
| Change bus | 16% | 84% | 10% | 90% | 18% | 82% | 13% | 87% | 17% | 83% |
| Bus-stop at destination | 62% | 38% | 23% | 77% | 64% | 36% | 47% | 53% | 56% | 44% |
| Overall percentage | 62% | 38% | 57% | 43% | 66% | 34% | 65% | 35% | 64% | 36% |

Source: Passenger Interview, Fieldwork Muscat 1990

## 8.3.10.4 - RELIABILITY OF THE BUS SERVICE

*Table 8.11* shows passengers' views regarding the reliability of the bus service together with their opinions in increasing the bus fare for a better service. Only 16 per cent of the passengers consider the bus service reliable, 59 per cent moderately reliable and 25 per cent unreliable. These proportions differ slightly in terms of nationality and sex. Among the Omani passengers, only 10 per cent of male passengers and 20 per cent of the females consider the bus service reliable. Among the non-Omani passengers, 20 per cent of male passengers and 12 per cent females consider the bus service reliable. This mainly reflects the purpose for which the bus usually is used. Omani males usually travel for various purposes at different times of the day to various places in the Muscat Area. Therefore, the majority of them see the bus service as moderately reliable due to the limited number of the bus routes coupled with the difficulty of changing buses to travel from one area to another. The passengers such as non-Omani males and Omani females who use the buses for work and shopping are more satisfied with the bus services.

However, when the bus passengers were asked whether they would be prepared to pay more for a better quality of service, about 78 per cent of the total passengers agreed and the Omani males emerged with the highest proportion, (see *Table 8.11*).

*Table 8.11* Bus Passengers' View: in the Reliability of the Bus Service

| Reasons | Omani | | | | Non-Omani | | | | Overall Passengers | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | Female | | Male | | Female | | | |
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| Reliable | 33 | 10% | 11 | 21% | 96 | 20% | 2 | 12% | 142 | 16% |
| Moderate Rel. | 216 | 65% | 31 | 58% | 257 | 53% | 15 | 88% | 519 | 59% |
| Unreliable | 82 | 25% | 11 | 21% | 130 | 27% | 0 | 0% | 223 | 25% |
| TOTAL | 331 | 100% | 53 | 100% | 483 | 100% | 17 | 100% | 884 | 100% |
| Passengers opinions in increasing the bus fare for better service. | | | | | | | | | | |
| Yes | 276 | 83% | 41 | 77% | 355 | 73% | 14 | 82% | 686 | 78% |
| No | 55 | 17% | 12 | 23% | 128 | 27% | 3 | 18% | 198 | 22% |
| Total | 331 | 100% | 53 | 100% | 483 | 100% | 17 | 100% | 884 | 100% |

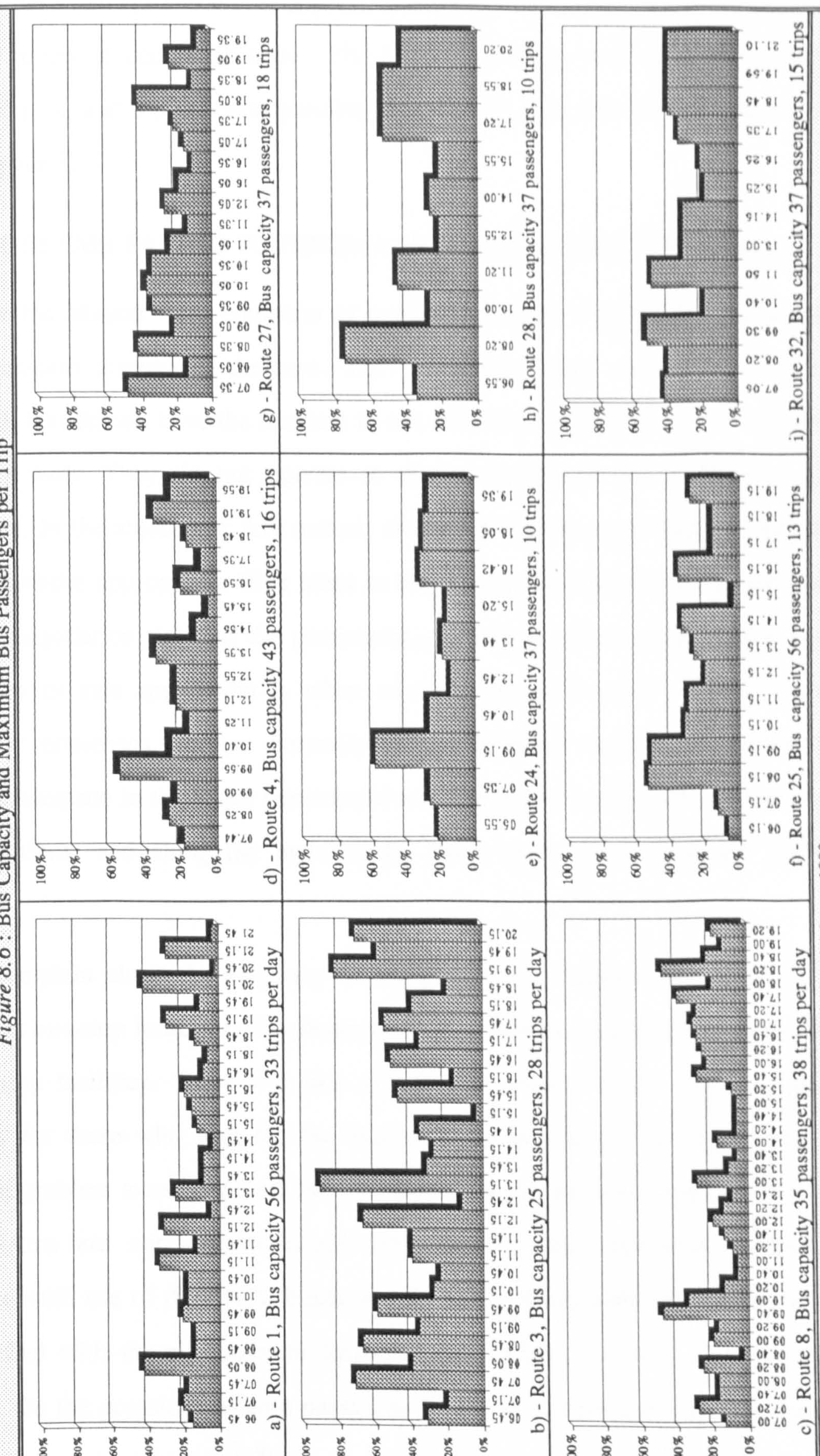
Source: Passenger Interview, Fieldwork Muscat 1990

### *8.4.11 - BUS CAPACITY AND MAXIMUM PASSENGERS PER TRIP*

*Figure 8.6* shows the bus capacity and maximum bus passengers per trip during the operating hours of buses covered by the survey. In most of the routes the buses run with a low volume of passengers, roughly less than half of their capacity. The high occupancy rate of the bus operating on route 3 is due to the low capacity of the bus itself, which operates temporarily as a replacement for the normal high capacity bus. In addition, the bus is air-conditioned and hence encourages more passengers.

There is no distinct demand peak in the daily pattern of bus passenger movements. In some instances the passengers peak hour occurs in the morning, and in others it

*Figure 8.6* : Bus Capacity and Maximum Bus Passengers per Trip




Source: Passenger Interview Survey ( passenger account) , Fieldwork Muscat 1990 occurs in the evening. The morning peak, sometimes, occurs in early morning and in some routes it occurs at noon. The evening demand occurs approximately between 6 p.m. and 8 p.m. corresponding to the evening personal travel peak hours ( see Chapter 3).

## 8.4 - PROBLEMS FACING POTENTIAL PUBLIC TRANSPORT USERS

People in the Muscat Area complain of a general lack of uniform distribution of public transport throughout the area. The public bus routes are limited and the paratransit taxi drivers have the freedom to run their taxis anywhere and at whatever time they wish. They do not operate in areas where they are unlikely to get passengers. In the absence of fare meters, the driver has the opportunity to ask the fare he consider appropriate. This leads to bargaining and the price often depends upon the negotiation skills of the passengers, journey length and time of the day. Uniformity of rate application is often missing, except for few popular routes where, by consensus, drivers normally charge standard fares. The paratransit service is adequate in the major commercial areas, around hospitals and government administrations, and along the main roads. Areas away from these are poorly served.

People complain about the adequacy of the public bus transport and the lack of convenient bus-stop locations. The majority of bus passengers are not satisfied with the bus-stop facilities. There is a lack of bus-stop shelters which causes a great difficulty for those who wait for the buses during the heat of the day. Another important problem associated with the hot weather is that the operating buses in the Muscat Area are not air-conditioned. This is the most significant complaint connected with use of the ONTC buses, nearly all the passengers interviewed were not satisfied with the air-condition facilities. Also there is a lack of connecting services. On the occasions when a passenger wishes to make a journey involving a change of bus, it may be difficult or impossible to complete the journey in a reasonable time. This applies to all forms of public transport. However, complaints are associated with use of the public buses such as poor bus frequency and time keeping and lack of travel information and facilities for female passengers.

## 8.5 - ROLES OF BUSES AND PARATRANSIT

The issue of whether it is best to encourage the operation of buses or paratransit modes (Taxis or pick-ups) on a particular public transport route is complicated. Account has to be taken of the benefits and disbenefits to all road users, not only those who use the public transport, in making the choice between the various modes of public transport. The suitability of a route for a certain mode mainly depends upon three main factors: (1), the capacity of the roads making up the route, (2), the volume and speed of traffic using the roads, and (3), the volume of demand for public transport. Leaving the many factors aside, buses are more appropriate where public transport demand and the volume of the traffic are high in relation to the road capacity. Paratransits are more appropriate where public transport demand is low and traffic volume is low relative to road capacity[11].

The essential point is that taxis and pickups take up more road space per passenger seat than do buses, and thus, for any given level of public transport demand and load factor, they require more space and cause more congestion than buses. The extent of the greater congestion effects of paratransit on other road users depends not only on the volume of other traffic in relation to the road capacity, but also on the length of the public transport route over which congestion occurs. For example, in the commercial areas, taxis circulate all the time causing unnecessary traffic congestion, whilst the continual stopping to pick up and set down passengers at random spots along the high speed highways is commonly considered the reason for most of traffic accidents and the congestion during the peak hours.

Paratransit operators, mostly self-employed, conduct their activities without any element of direct government subsidy, (i.e. they provide an important public service at no cost to the government). Public bus transport, on the other hand, is heavily subsidised by the state[12]. As taxis and pick-up drivers are free to choose vehicles, routes, frequency and hours of operation, they are more flexible and well suited to adjust to lows of supply and demand. Due to their limited capacity, they are able to provide transport even at low levels of demand, thus reaching even those areas where the demand would be insufficient to support the use of larger buses at desirable frequencies.

Bus operations can be easily controlled compared with pick-ups and taxis. While the bus travels at much the same speed as a taxi or pick-up, it stops more frequently due to its large capacity and takes a longer time to decelerate and accelerate than other modes. Whereas passengers have to walk further to board a bus as it stops only at fixed places, they can board or alight from a taxi or a pick-up at any point along its route. The influence of these factors on the total journey time depends upon the average speed while moving, which depends in turn upon the alignment of the road and the level of traffic in relation to the road capacity, and upon the length of the route.

Taxis are best-suited for trips without being fixed to set routes, they offer a higher standard of personal door-to-door service which cannot be achieved by public buses or pick-ups. Taxis cost more to operate per passenger seat than do pick-ups and buses, and thus, require higher fares for any given journey length and load factor. On the other hand, taxis run more frequently between terminals than do buses and pick-ups for a given passengers demand and load factor, and thus have a short headway and lesser waiting time. The planned occupancy of paratransit at terminals may be higher than that of buses; as a consequence, in low demand situation waiting times as a function of headway will be higher for paratransit than for buses. The relationship between passenger trip length and route length affects the number of time for which a seat can be charged on vehicle journey, and hence affect the total revenue and the fare level needed to cover costs.

The quality of a public bus transport system which is measured in terms of efficiency, flexibility, higher mobility, regularity and reliability(13), is also an important factor that influences the choice of a certain form of transport on a particular route. However, the question of who benefits needs to be addressed from such an arrangement. It is the potential users of public transport who should benefit in particular and the other road users in general. Therefore, it is important to determine the role of the route in question and its demand in relationship to other routes in the area and accordingly an appropriate mode of public transport that can meet its demand effectively can be located within an overall integrated transport system.

## 8.6 - CONCLUSION

The great majority of motorised trips in most cities in developing countries are made in public transport vehicles(14). However, in the Muscat Area, the greater share of personal travel is carried out by private means of transport. The dominance of private transport leads to severe congestion on urban roads, and a steady decline in the patronage of public transport in towns and cities of the developed world(15). In common with many other third world cities public transport facilities in the Muscat Area are inadequate and the level of service is much lower than in the developed world. However, unlike most of the third world countries, public bus transport in Oman in general and in the Muscat Area in particular, suffers from low volumes of bus passengers.

Due to the high proportion of car availability per household in the Muscat Area, private vehicles are the dominant mode of travel. However, public transport services are greatly needed for people who cannot afford a car or cannot drive. Being road-based, public transport modes include buses, taxis and pick-ups. The bus service is provided by the state-owned Oman National Transport Company(ONTC). Taxis and pick-ups are privately-owned and are not regulated by law. They compete with the bus service and they are more available where there is a high demand. They have a higher frequency and journey speed. Therefore, taxi and pick-ups have a much higher share of passengers than the ONTC buses. In general, the public transport services are poor and unfairly distributed throughout the Muscat Area.

Taxis in the Muscat Area are the privately owned ordinary saloon cars mostly driven by their owners. The taxi services are not centrally organised and there are no meters, therefore, the driver has the opportunity to ask the fare he considers appropriate. In the absence of a system for operating taxis, the service does not operate in places where it is unlikely to get passengers. Pick-ups are Japanese double-cabin vehicles. They can be hired to carry goods and passengers and their operations are uncontrolled. Compared with taxis and buses, pick-ups have a higher proportion of long trips. They operate mainly along the regional roads and between the main commercial areas. Like taxis, pick-ups cause accidents and congestion in the peak hours because of picking up and setting down passengers at random places along the highways.

The ONTC buses are operated throughout the country. At present, there are nine bus routes during the weekdays and two routes at the weekends in the Muscat Area. There are 11 bus routes from the Muscat Area to the other parts of the country and one international route between Muscat and Dubai. The ONTC also provides contract carriages for ministries and other major private sectors. The ONTC follows a radial operating system with two main bus stations in Muttrah and Ruwi. The frequency of the bus services varies from 15 to 60 minutes. The low volume of passengers does not allow for a high standard services in the Muscat Area.

The development planning in the Muscat Area favoured private car-ownership and, therefore, roads and intersections were built to provide free-flow conditions. This worsened traffic and environmental problems. The flexibility and increased mobility of private transport together with the problems of public transport (e.g. waiting in hot weather, and slow and uncomfortable journeys) deters people from using buses.

Thus, in almost all the routes the buses run with a low volume of passengers, roughly less than half of their capacity. However, most of the bus passengers are non-Omani, reflecting the higher rate of car ownership among the Omanis. Most of the bus passengers are privately employed with low incomes. Muttrah municipality has the majority of bus passenger movements. People in Muscat use the bus to go to the shopping areas because the service is adequate there.

The household members see the distance to the bus-stop as the main reason for not using the bus services followed by the reason that the car is more available and comfortable, and the lack of air-conditioned buses. Unlike the household members, vehicle divers see the availability of private transport and its comfort as the most important reason for not using the bus. However, the lack of convenient bus-stop location, inadequate bus frequency, length of the journey, the unreliability of the bus service, and poor bus-stops facilities are other discouraging factors. The lack of air-conditioned buses is the most significant complaint connected with the use of the ONTC buses followed by the lack of shelter and poor bus connecting services. Complaints such as the distance to the bus-stops from home or to destination, bus frequency, tariff, time scheduled and travel information are also recorded.

A high proportion of the bus passengers consider the bus service as moderately reliable. This proportion slightly differs in terms of sex and nationality. The majority of bus passengers are prepared to pay more fare for better quality of bus service. Most of the private vehicle drivers interviewed were unwilling to use the buses even if the service quality was improved.

## 8.7 - RECOMMENDATIONS

The provision of access and mobility is essential for the efficient organisation and function of a city(16). At present, any policy aimed at improving the use of the existing urban transport services must necessarily focus on the problem of congestion, and specifically on the competition between cars and buses for urban road space[7]. The predominant investment on road construction as a means of enhancing mobility in urban areas is not effective without the relative merits of traffic management and public transport improvement. The demand management of road use such as restrictions on the use of private vehicles should represent not a disapproval of its social value and ability to raise the standard of living, but a common awareness of its unsuitability for certain types of trips in congested areas (see Chapter 6).

Public transport systems provide the most efficient means of moving large numbers of people. Bus services, in particular, provide considerable flexibility in meeting demands for various levels of quality and quantity[16]. Therefore, a reasonable solution to the transport problems caused by the increase of private motor vehicle and their use may lie in developing an efficient public transport system which can provide an attractive and convenient alternative to the private vehicle. Besides, effective public transport services are badly needed for these who cannot afford a car or are unable to drive. If such an option is provided and it is reasonably cheap, convenient and accessible, the quality of urban life becomes relatively more attractive.

In the Muscat Area, the development of a public transport system must be the first priority in order to achieve effective transport services and to overcome the transport difficulties caused by the excessive use of private vehicles. The improvement can take account of all forms of public transport, not only the buses. It is important to establish integrated systems that exploit the advantages of the various modes of public transport ensuring unnecessary competition and a greater number of users served. Integration involved not only physical facilities (stations, routes, vehicles etc.), but operating procedures and fare policies as well. Therefore, it is necessary that their co-ordination and operating policies are ensured and supervised through a common planning authority.

It is a desirable national objective that the government sets a clear national public transport policy. This can define the nature and the extent of operations by the bus service and, equally important, by the taxis and pick-ups operators. In order to be effective, the policy can identify qualitative and quantitative objectives and spheres of operations into which the three modes would be authorised to operate.

Taxis seem to be more suitable to serve the inner urban areas where the majority of trips are short and door-to-door service is required. Where the demand is high, particularly between the commercial areas or between the commercial areas and the major residential settlements, buses are more appropriate. In order to make them more attractive, a very high frequency of service with low fares is essential. Bus stops in the long distance routes can be limited in order to minimise travel-time. Pick-ups or the new privately owned microbuses are more appropriate where the demand would be sufficient to support their use at desirable frequencies to run profitably without any competition with other forms of public transport. Formulating such an operation policy with a minimum control and enforcement regulations requires full co-ordination and agreement between the transport users, the transport operators and the government authorities.

Public bus services are significantly better users of scarce road-space than cars and other small vehicles. Therefore, government investment may see public transport as an excellent value against the very expensive urban road network development and the provision of parking facilities. Particularly, the construction of urban highways and their complex intersections are not necessarily the most effective method of solving transport problems created by the heavy use of private vehicles. The ONTC has proposals for extending bus services in the Muscat Area and in other parts of the country, but the need to run profitable bus services made it impossible. However, operating a widespread network of bus service in the Muscat Area requires financial support. Unless this support is provided by the government unprofitable public bus will be provided where the operating subsidies are specifically provided by government(10).

In order to inculcate public transport awareness and to improve occupancies, it is important that the public perceive bus services are convenient, safe, suitable and reliable. To achieve this, it is important that attractive, comfortable, safe and durable buses and coaches are used together with attractive fares. Providing higher frequency, lower-capacity air-conditioned minibuses for short and medium distance services is desirable. This can be combined with the provision of bus bays, shelters, stations and stands that make roadside infrastructure adequate to produce optimum efficiency. Publicity campaigns are necessary to create a general awareness of the individual advantages offered by public transport, and to convince private vehicle drivers that public transport is a good alternative to the private car for certain type of journey such as work trips.

Thoughtful planning can make the walk to the bus stop easier and more pleasant. This can be achieved, if the bus services are considered in the designing of the road network, residential and employment areas, public facilities and amenities. Bus-stops can be located at points where passengers may board and alight safely and conveniently and where disruption to other road users is minimised(17). At all the major bus stops, stations and bus stand on the various routes, provision can be made for a modal interchange, (i.e. bus passengers can change over to other buses or other forms of public transport or vice versa). This may not include the bus roadside infrastructure only but also taxis and pick-ups stands. The interchange points can be provided with sufficient facilities and the large ones with refreshment facilities.

Taxis in the Muscat Area play a major role within the urban areas, and provide adequate service for people who travel short-distance trips and need door-to-door service. At present, it is not possible to telephone to order a taxi, therefore, it is necessary to introduce the dial-a-taxi system in the poorly served areas such as Boashar where the demand is low to satisfy public transport to operate economically. The dial-a-taxi system can be provided with appropriate communication facilities to enable the taxi operators to provide this service efficiently and profitably. Public transport vehicles like pick-ups and taxis can be legalised and formal parking and stopping facilities should be provided to increase their efficiency. Their role can be complementary to the ONTC bus system as they cost almost nothing to the public sector. Due to their low carrying capacity, they are economical to run even in low demand routes. They are more responsive to customer's needs and more innovative in finding ways to cut costs.

The above suggestions for improving the efficiency of public transport are considered in terms of the scale and the service provided by each mode of public transport. It is also important to consider the recommendations implied in this study in order to achieve the best and proper use of land, integrated with a safe and effective transport system, taking account of the changing needs of the urban area and within an environment whose quality should be maintained and enhanced.

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# CHAPTER 9
# CONCLUSION

This study has focused on the road transport problems in the Muscat Area. Its objective was to contribute to understanding in two distinctive and complementary ways. First, it aimed to characterise the nature of the transport problems in Muscat and develop an understanding of the factors that contribute to them so as to make predictions of the future. Second, it attempts to provide useful information for planners and decisions makers through a series of recommendations derived from data analyses and interpretation. The work is, therefore, of both a basic and an applied nature. Here we are concerned with the conclusions derived from the more basic aspects of the work. Conclusion of the more applied aspects, in the form of recommendations are to be found at the end of each chapter in which the appropriate analyses have been conducted.

The growth of motor vehicles and their use make it very difficult for many cities in the developed world to provide sufficient transport facilities. Unlike many cities in the developing countries, where the great majority of motorised trips are made in public transport vehicles, in the Muscat Area the greater share of personal travel is carried out by private means of transport. However, the continuous increase in the number of vehicles in the Muscat Area creates serious social, economic, and environmental problems. The area is already suffering from traffic accidents, congestion and above all there is a great demand for physical space and very costly infrastructure which makes it necessary to look for an effective transportation system.

Urban travel is simply a reflection of the underlying human activities, the ways in which these activities are organised in space and time, and the transport facilities and resources available to facilitate interaction between spatially separated groups of activities. In the past twenty years there has been a substantial growth in Oman's economy. The Muscat Area has been the centre of the development. Its population increased rapidly from 25,000 persons in 1970 to almost half a million in 1989 due to internal and external migration to fill jobs generated by a strong economy. The remarkable increase in population led to the expansion of the Muscat Area to provide residences, work places and other facilities. Economic prosperity has given people the opportunity to possess their own private means of transport, which has resulted in a rapid increase in the number of vehicles in Oman in general and the Muscat Area in particular.

The analysis is focused around a set of questions the first of which relates to trip characteristics in the Muscat Area. The characteristics of movements in the Muscat Area provide a clear picture of the behaviour of persons as they move about within the urban area and answer the questions of where, how, why and when they travel in the Muscat Area. The 528 households surveyed in the Muscat Area generate about 7,961 trips on a typical week day. In the course of an average weekday, each person makes 2.99 trips and each vehicle makes 4.64 trips. There are 15.08 person trips or 5.71 vehicle trips per household each day and most of them are internal trips within the boundary of the Muscat Area with an average car occupancy of 1.72 persons.

There is a wide variation in trip generation between the Omani and non-Omani populations. The Omani households generate more trips per day than the non-Omani households. However, the average number of trips for an Omani person is lower than the non-Omani person and this is mainly a function of household size, where the average household size in the Omani is twice these of the non-Omani households. The high number of trips generated per Omani household and the drop in trips per person indicates that there is a minimum number of trips associated with earning a living and running a household. These trips are made regardless of household size. The future average trip per person among the Omani is expected to rise because a greater percentage of the Muscat population will be in small households which exhibit higher trip rates per person than larger ones.

With respect to the road network, questions were raised about its ability to serve the needs of the area, how well it copes with traffic movement and how topography has influenced its development. Physical planning in Oman has been undertaken in the context of extremely rapid change since 1970 and transport planning is no exception. The government anticipated that the provision of an adequate road network would be an essential first step towards a successful implementation of the new development programmes. A great deal of effort was made by the government to ensure that the development of the Muscat Area road network takes full account of existing and future requirements. The Muscat road network is controlled and directed through planning programmes. The existing deficiencies are due to rapid urban growth, among other factors such as lack of planning data and qualified staff, poor planning techniques and study outcome, and lack of project implementation.

The topographical aspects influence the shape of the Muscat Area road network. They limit its access to the rest of the country and create a significant constraint upon the improvement of the road network. This is reflected in the limited number of options for road network alignment and in the high construction cost. The lack of balance between the demand and the supply of roads within the available funds is considered to be an important limiting factor in the improvement of the road network. Time-phasing and priorities for road projects have not been carefully selected to fulfil the required demand. The recent studies were mainly concerned with rearranging the 1982 road network proposals into three phases without any visible priority order. This resulted in a very high investment programme in the road network, which is beyond the budget allocated to Muscat Municipality for road development. In the absence of alternative efficient technical options these high investment programmes lost sight of what can be achieved.

The urban road network is mostly composed of the Sultan Qaboos Highway and its offshoots on either side to major residential areas. The existing deficiency of the road network includes the lack of an alternative route to the Qaboos Highway, an unrecognisable road hierarchy, inadequate road junction capacity, poor pedestrian facilities, insufficient local access and roads in the major commercial areas, and inadequate cross highway drainage.

The study also discussed the impact of the motor vehicles. The Muscat Area is already suffering from traffic congestion and in the light of the recent Muscat Area Structure Plan future land use strategy, the present study predicts a higher number of long distance trips. Hence, there will be a need for new highways.

Traffic accidents and their human casualties are a major scourge in Oman. Road accidents are very serious and their reduction requires the efforts of different organisations and individuals. The seriousness of traffic accidents in Oman, is illustrated by the high accident death rates compared to the rest of the world. As the present factors are likely to persist, these very high rates are expected to increase, unless immediate improvement programmes are introduced on a full scale and on the dangerous locations.

There is no single solution to the problems created by private motor vehicles. However, three important aspects can be taken into account in this respect: engineering, education and enforcement. A fuller understanding of the problems is required before considering any effective measures to create a safe and suitable environment. The prevention of accidents and the promotion of free movement requires good design and control of the road system, a close study of human behaviour and movements, well-maintained vehicles, an acceptable set of rules to be obeyed and, most importantly, a high degree of discipline by drivers and other road users.

As for parking problems, they were recognised in the old parts of Muscat Area in the early 1970s as the result of the increase in the number of vehicles and their use in an urban environment best suited to non-motorised modes of transport. With the rapid increase in the number of vehicles, the issue of vehicle parking is a serious and difficult problem, especially around commercial and government administration institutions. In the face of this growing demand for parking spaces, the available spaces at the present time are quite primitive. The topographical nature of Greater Muttrah limited the flat land available for the various developments, resulting in an acute shortage of parking spaces in the commercial areas and with the anticipated increase in the number of commercial activities in these problematic areas, parking problems are expected to become worse in the absence of an immediate solution.

Vacant land is the most common type of parking used in Muscat Area. Although finding a parking space in the Muscat Area involves little difficulty, finding a parking space in Greater Muttrah involves some difficulty and greater difficulty in the shopping areas. There is a severe shortage of parking spaces in the shopping and business areas, and a low rate of turnover parking space resulting from the lack of regulations to control the use of parking spaces. Due to the lack of defined on-street parking spaces and regulations coupled with the hot weather, motorists park their vehicles anywhere along the road as close as possible to their destination to avoid the heat. This method of parking results in the disorganised accumulation of vehicles which affects the streets capacity, and creates congestion and delay in the traffic flow.

The final question raised in the study focused on public transport and the role of Oman National Transport Company (ONTC) buses. In common with many other third world cities, public transport facilities in the Muscat Area are inadequate and the level of service is much lower than in the developed countries. However, unlike most of the third world countries, public bus transport in Oman in general and in the Muscat Area in particular, suffers from low volumes of bus passengers because of the large number of private vehicles However, public transport services are greatly needed for people who cannot afford a car or cannot drive.

The ONTC buses are operated throughout the country. At present, there are nine bus routes during the weekdays and two routes in the weekends in the Muscat Area.

There are eleven bus routes from the Muscat Area to the other parts of the country and one international route between Muscat and Dubai. The ONTC also provides a large number of contract buses for ministries and other major private sector employers which constitutes the main source of the company's income. The ONTC follows a radial operating system with two main bus stations in Muttrah and Ruwi. The frequency of the bus services is low and the low volume of passengers does not allow for high standard of services in the Muscat Area.

Development planning in the Muscat Area has favoured private car-ownership and, therefore, roads and intersections were built to provide free-flow conditions. This worsened traffic and environmental problems. The flexibility and increased mobility of private transport together with the problems of public transport deter people from using buses. Most bus passengers are non-Omani, who are privately employed, with low incomes.

The household members do not use ONTC buses mainly because of the distance to the bus-stop and the lack of air-conditioned buses. Private vehicle drivers see the availability of private transport and its comfort as the most important reason for not using the bus. The lack of convenient bus-stop locations, inadequate bus frequency, length of journey, the unreliability of the bus service, and poor bus-stops facilities are other discouraging factors. The lack of air-conditioned buses is the most significant problem connected with the use of the ONTC buses followed by the lack of shelter and poor bus connecting services. Complaints such as the distance to/from the bus-stops, bus frequency, tariff, time scheduled and travel information are also recorded.

A high proportion of the bus passengers consider the bus service as moderately reliable and most of them are prepared to pay more fares for a better quality of bus service. Unlike bus passengers, most of the private vehicle drivers interviewed were unwilling to use the buses even if the service quality was improved.

The urban transport problems are an integral element of a much broader collection of problems and issues associated with growth of the Muscat Area. The lack of compatibility and agreement between development planning, human activities and environmental conditions create the problems of urban transport in the Muscat Area. However, there is no simple remedy for the problems created by complex and interrelated issues. Any attempt to the solve urban transport problems should consider also other city growth issues such as social and economic aspects and land use planning.

Further comprehensive transport studies covering all aspects of urban transportation systems need to be carried out because, firstly, the aim of this study was to investigate the existing transport problems in order to find acceptable solutions to the existing problems and suggest proper guidelines for future transport planning policy, and secondly, it is understandable that comprehensive transport planning would not be achieved within the limited time and resources available for this research. Also, it may be difficult to propose for the future without a vision of what will happen.

However, it is desirable to update the existing Capital Area Transport Study in conjunction with recent studies by the Ministry of Housing, in order to integrate the transport planning process with the land use planning process, through an updated comprehensive land use/transport study of the Muscat Area. Any updated transport study can make optimum use of the findings of this study and other available information provided by recent studies in the field.

In the light of issues raised in this study further work needs to be undertaken in four main areas. First, public transport uses less road space and fuel per passenger km than do private cars. Therefore, studies must be undertaken on the public transport system in order to improve its efficiency and strengthen its role in the Muscat Area as well as in the whole country. Indeed, the development of public transport must come to be seen as part of a reasonable solution to the problems caused by the rapid increase in the number of private vehicles and their heavy use in the area. Secondly, the significance of freight movements within the Muscat Area and between it and the rest of the country as a contributory factor to transport problems and of the movement of non-Omani labourers from labour camps have not been investigated in this study. These issues need consideration. Thirdly, an important theme in this study has been the way in which the fragmentation and dispersal of decision making on transport/ land-use issues amongst government and municipal departments has contributed to transport problems. It is important to inaugurate studies identifying more closely the role of each institution in the transport and land-use planning and control system and studies investigating structures that would promote more efficient co-ordination between institutions. Finally, there is an urgent need for studies comparatively evaluating the recommendations made in this study to provide inputs into the decision making and implementation processes.

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# APPENDIX "A"
# HOME INTERVIEW

### *A-1-General*

The Home Interview was adopted to enable the maximum amount of information to be collected from the residents of the Muscat Area. Hence this survey had two objectives.

1 - To collect information relating to the household characteristics of the study area in order to identify the socio-economic characteristics of the trip maker.

2 - To provide a clear picture of a typical weekday person trips in terms of where and when trips begin and end, origin and destination purposes, and mode of travel.

The information collected in the Home Interview is shown in *table A1*.

| ***Table A 1*: Information collected in Home Interview** | |
|---|---|
| Household data | Travel data for each trip made by a person over 5 years of age during the 24 hours of the day for which the data was requested |
| * Total number of persons in each by nationality and age/sex group.<br>* Total number of employees by occupation/sex group.<br>* Total number of persons working in the same area as they live by sex.<br>* Total number of vehicles and drivers by sex<br>* Total income per month.<br>* Reasons for not using ONTC buses as mode of travel.<br>* Opinions on the availability and efficiency of public transport. | *All travellers*<br>* Origin and destination areas.<br>* Times of leaving and arriving.<br>* Origin and destination purposes.<br>* Mode of travel.<br><br>*Vehicles drivers only*<br>* Type of parking.<br>*Availability and duration of parking.<br>* Number of passengers. |

### *A-2- Survey Timetable*

The development of the questionnaire began on the 10th of February 1990. The proposed time for starting the survey was 24th of March with a view to completing the survey before the Summer holidays; so that school travel could be included in the measurements. The survey was delayed to the 5th of May 1990 for two reasons. First, according to the Royal Decree number 87/88, surveys are not permitted in Oman without approval from the Directorate General of National Statistics. Approval was delayed due to their interest in the questionnaire by requesting more detail about the study purpose and the survey outcome, provided that they would participate in the distribution of the questionnaires after their interviewers had been trained.

Secondly, because of the month of Ramadan where the travel habits differ from the rest of the year. The survey was conducted over a period of four months. In the first 7 weeks of the survey, 80% of the questionnaires were distributed with the assistance of the interviewers from Directorate General of National Statistics. The rest of the questionnaires were distributed by the researcher himself.

### *A-3- Development of Questionnaire*

Having reviewed Land Use and Building Survey in the Muscat Housing Study (1989), traffic zones were defined. The first step of the survey to design an appropriate questionnaire in Arabic and English (*Figure* A1) to collect the required information as accurately and efficiently as possible, and to allow appropriate coding and data handling. The following points were considered during the development of the questionnaire:-

1 - It was anticipated that many people would have great difficulty in giving an accurate location of the trip's origin and destination without an appropriate address system. Therefore, internal traffic zones were based on well defined districts covering the entire Muscat Area, and the external zones were established in the regions of the country and neighbourhood countries. Whilst interviewing, the interviewees were requested to write either name of the area or its numeric code as listed clearly at the bottom of the Journey Information Sheet.

2 - Attention was paid to improve the rate of response and the quality of the data. A clear and convenient set of definitions and instructions to answers that the interviewee needed to elicit and what was required from him were provided. An example was also given to show how to complete the form.

3 - A Pilot survey was carried out to clarify many things needed to be known before the major survey, such as, the adequacy of the questionnaire, suitability of the survey and coding method, the efficiency of the instructions and the general briefing of the interviewers.

### *A-4- Method of Survey*

In Oman, as in many Arabian countries, carrying a direct personal interview with a female is difficult due to socio-cultural reasons. Therefore, a semi-direct method was adopted for the home interview. The questionnaires were delivered with a covering letter explaining the purpose of the survey to a sample of the population for completion at their convenience. The interviewers, on collecting the questionnaires, checked to ensure that correct and complete answers were given by asking direct questions. Compared with a fully-direct method this method proved, during the pilot survey, to be more convenient to both the interviewees and interviewers, and thus, several visits that were needed to secure an appointment with head of the household, were avoided.

### *A-5- Sample Selection*

The Weidleplan Consultants in their Muscat Housing Study 1989, estimated the Muscat population at 405,278 and the occupancy rate at 6.96 person per average household. The Institute of Traffic Engineers in its Manual of Traffic Engineering studies recommends sample sizes based on the population of the study area. *Table*-A2 shows typical sample sizes for Home Interview Surveys in transportation studies.

*Table A2:* Home Interview Sample Size

| Population Size | Simple Size (%) |
|---|---|
| Under 50 000 | 20.00 |
| 50 000 - 150 000 | 12.50 |
| 150 000 - 300 000 | 10.00 |
| 300 000 - 500 000 | 06.66 |
| 500 000 - 1000 000 | 05.00 |
| Over 1000 000 | 02.50 |

Source: Salter, R. J. (1989), *Highway Traffic Analysis and Design*, 2nd edition, Macmillan Education Ltd, London

Based on the Muscat household occupancy rate, the required households sample size was one per cent of the total households, to give 6.66% of the total population. Therefore, with the assistance of the Directorate General of National Statistics a sample of 1.5 per cent was selected at random per traffic zone. The selection of 1.5 per cent was aimed to achieve a successful sample of one per cent of the total households. The total number of households per traffic zone was determined according to the Development Council 1989 estimates.

Form a total of 690 questionnaires distributed to the homes in Muscat, 605 were returned (i.e. 87 per cent of the distributed samples). After examining them, the number of valid completed answers was 528 (i.e. 1.2 per cent of the total estimated households), ( *Table*-A3 ). The invalid replies were either answered incompletely or unrealistically. The analysis was therefore based only on the completed and valid samples.

### *A-6- Interviewing Procedure*

With the assistance of the interviewers from the Directorate General of National Statistics, the questionnaires were sent to the homes selected in the study area, taking into account that we had no access to some households either to deliver or to collect the questionnaires in the absence of the head of the household or an adult male. Each interviewer was expected to complete interviews at two allocations of 20-25 households in the course of a five-day cycle over the weekday Saturday-Wednesday. The following procedure was adopted for:-

*I - Day 1.* Interviewers delivered questionnaires to the households in the first allocation (one journey information sheet per resident over the age of 5 years), explained the purpose of the survey and method of filling in the forms and recorded certain checking information ( *Figure* A2 )

***II- Day 2.*** The people in the households visited on day one were required to complete the journey information sheet. The interviewer used this day to the catch upon any backlog from the first allocation and delivered the questionnaire to the second allocation of the households.

***III- Day 3.*** The interviewer revisited households given the questionnaires on day one, and collected and checked the questionnaires by direct interviews. Also, to deliver any questionnaires left from the second allocation.

***IV- Day 4 and 5.*** The interviewer revisited households given the questionnaires on day two and three respectively, to collect the questionnaires.

Careful briefing and instruction of the survey teams was essential in order to achieve efficient and unbiased surveying. At intervals during the survey, the interviewers were re-briefed by researcher in order to ensure maximum understanding of the survey purposes and to obtain as good a response as possible from those interviewed. Written instructions were issued to each interviewer so that interpretation of questions would be uniform and the procedures to be followed clearly understood.

***Figure* A2: Interviewing Diary**

1- Traffic Zone No. : .......................... 4- Interviewer Name : ............................
2- Block Number: ............................. 5-Total Number of Forms: ......................
3- Mimi. Distribution : ...................... 6- Mini. Required :.................................

| No | N0. of persons | Date of Delivery | Date of collection | Block No. | Notes |
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*Table* A3: **Sample Distribution**

| Traffic Zones | Total households | Distributed total | Distributed percent | Collected total | Collected percent | Valid total | Valid percent |
|---|---|---|---|---|---|---|---|
| 1 - Sidab, Bustan, Qantab | 909 | 20 | 2.2% | 20 | 2.2% | 19 | 2.0% |
| 2 - Muscat | 1634 | 30 | 1.8% | 24 | 1.4% | 22 | 1.3% |
| 3 - Muttrah | 3241 | 45 | 1.4% | 40 | 1.2% | 34 | 1.0% |
| 4- Darsait, Ruwi North, CBD | 5462 | 85 | 1.5% | 78 | 1.4% | 73 | 1.3% |
| 5- Ruwi South, Hamriya, Adai | 5656 | 80 | 1.4% | 65 | 1.1% | 57 | 1.0% |
| 6 - Wadi Kabir | 2696 | 40 | 1.5% | 34 | 1.3% | 25 | 0.9% |
| **{1} Greater Muttrah** | **19598** | **300** | **1.5%** | **261** | **1.3%** | **230** | **1.2%** |
| 7 -Wattayah | 1131 | 19 | 1.6% | 16 | 1.4% | 14 | 1.2% |
| 8 - Qurum | 1548 | 25 | 1.6% | 24 | 1.5% | 20 | 1.3% |
| 9 - Qaboos City, Inf. City | 2189 | 30 | 1.4% | 27 | 1.2% | 25 | 1.1% |
| 10 - Qurum Beach | 314 | 05 | 1.5% | 05 | 1.5% | 04 | 1.3% |
| 11- Al-Khuwair | 2824 | 45 | 1.6% | 40 | 1.4% | 37 | 1.3% |
| 12 - Ghabra, Boashar | 999 | 14 | 1.4% | 10 | 1.0% | 10 | 1.0% |
| 13 - Adheiba | 908 | 14 | 1.5% | 08 | 0.9% | 07 | 0.8% |
| 14 - Ghala Industrial State | 1024 | 15 | 1.5% | 12 | 1.2% | 08 | 0.8% |
| **{2} Boashar** | **10973** | **167** | **1.5%** | **142** | **1.3%** | **125** | **1.1%** |
| 15 - Airport Heights | 715 | 10 | 1.5% | 09 | 1.4% | 06 | 0.8% |
| 16 - Mawelah | 892 | 15 | 1.6% | 12 | 1.3% | 11 | 1.2% |
| 17 - Al Hail | 1549 | 30 | 1.9% | 28 | 1.8% | 24 | 1.5% |
| 18 - Al Khod | 1691 | 30 | 1.7% | 28 | 1.6% | 25 | 1.4% |
| 19 - Seeb Town | 1884 | 31 | 1.6% | 30 | 1.6% | 28 | 1.5% |
| 20 - Manuma | 1242 | 23 | 1.8% | 22 | 1.6% | 19 | 1.5% |
| 21- Ma 'abela | 1667 | 25 | 1.5% | 23 | 1.4% | 20 | 1.2% |
| 22 - Qaboos University | 399 | 07 | 1.8% | 07 | 1.8% | 07 | 1.8% |
| 23 - Rusail Industrial State | 15 | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **{3} Seeb** | **10054** | **171** | **1.7%** | **159** | **1.6%** | **140** | **1.4%** |
| 24 - Al Amarat | 881 | 15 | 1.7% | 12 | 1.4% | 11 | 1.3% |
| 25 - Madinat Al Nahda | 2887 | 37 | 1.4% | 30 | 1.1% | 22 | 0.8% |
| **{4} Al Amarat** | **3768** | **52** | **1.5%** | **42** | **1.1%** | **33** | **0.9%** |
| **Muscat Area** | **44393** | **690** | **1.5%** | **604** | **1.3%** | **528** | **1.2%** |

Source : (1) Households Survey 1989. (2) Directorate General of National Statistics, Development Council; own calculation per traffic zone.

## *FIGURE A1: HOME INTERVIEW*

Traffic Survey

Dear Sir,

As you know during the last two decades the buoyant national economy has resulted in the rapid development of the Muscat Area as a commercial, industrial and service centre. Therefore, a great deal of effort was made by the government to ensure that the development of the transport system takes full account of existing and future requirements, but the rapid urban growth, among other factors, creates the existing traffic congestion and other road transportation problems. To clarify where the improvements need to be made, it is necessary to carry out this survey in order to build-up a picture of the transport situation in Muscat Area.

Your co-operation will be highly appreciated and will certainly contribute towards the improvement of the existing conditions, where necessary to meets your needs. The questionnaire consists of the following three parts:

Part one: General information about the household for the head of the household

Part two: For household members concerning their opinions about public transport.

Part three: 24 hours personal trips for every member of the household over 5 years of old.

We would appreciate it if you would answer the questions as accurately as possible. Please note that your name and address are not part of this questionnaire so your confidentially is assured. The interviewer who delivered this questionnaire will return to collect it, and answer any quires you may have.

Thank you for your co-operation

*Please read the instructions carefully before answering the questionnaire*

## *FIGURE A1*HOME INTERVIEW

| | |
|---|---|
| Form Number .................................. | Date ................................................ |
| Area Number .................................. | Day ................................................ |

## PART ONE

(1) - How many persons live in this household? ..............................................................................

(2) - Nationality 1 - Omani .................... 2 - Non-Omani .............................

(3) - Please classify your household members according to the following age groups:

| | a - Male | b - Female |
|---|---|---|
| 1 - O - 4 Years | .................. | .................. |
| 2 - 5 - 14 Years | .................. | .................. |
| 3 - 15 - 24 Years | .................. | .................. |
| 4 - 25 - 39 Years | .................. | .................. |
| 5 - 40 - 65 Years | .................. | .................. |
| 6 - Over 65 Years of age | .................. | .................. |

(4) - Please classify your household members according to the following employment groups:

| | a - Male | b - Female |
|---|---|---|
| 1 - Student | .................. | .................. |
| 2 - Government employed | .................. | .................. |
| 3 - Privately employed | .................. | .................. |
| 4 - Self- employed | .................. | .................. |
| 5 - Unemployed | .................. | .................. |

(5) - How many members of your household are working or schooling in the same area they live ?

1 - Male .................. 2 - Female ...................

(6) - How many persons in this household can drive ?

1 - Male .................. 2 - Female ...................

(7) - How many cars are used by your household ?

1 - Owned car ............................................

2 - Government car ............................................

3 - Company car ............................................

(8) - Can you state approximately your household income per month?
( please add up all source of income and tick the appropriate box)

1 - Less than 150 R.O. ☐
2 - 150 to 200 R.O. ☐
3 - 201 to 400 R.O. ☐
4 - 401 to 600 R.O. ☐
5 - 601 to 800 R.O. ☐
6 - 801 to 1000 R.O. ☐
7 - More than 1000 R.O. ☐

## INSTRUCTIONS AND DEFINITIONS

**HOUSEHOLD:** A person living alone, or a group of people living together, preparing and eating meals together and benefiting from a common housekeeping

**HEAD OF THE HOUSEHOLD:** Is a member of the household who owns, rents, or otherwise legally responsible for the accommodation. Usually the husband in case of married couple living together.

**HOUSEHOLD INCOME ....** Total monthly income of all household members obtained from all sources, including wages or salary for employment, profits and salary from business, government assistance and rent.

**LIVING AREA** Muscat Area has been divided into 25 areas for the survey purpose (see the enclosed map) and the areas out side the boundary of Muscat Area into 8 external areas.

FOR EXAMPLE ....

Area one includes Sidab, Al-Bustan and Quntab
Area two is Muscat old town only .

- so -

| | |
|---|---|
| 1 - Sidab, Bustan, Qantab | 13 - Adheiba |
| 2 - Muscat | 14 - Ghala Industrial State |
| 3 - Muttrah | 15 - Airport Heights |
| 4- Darsait, Ruwi North, CBD | 16 - Mawelah |
| 5 - Ruwi S, Hamriya, Adai | 17 - Al Hail |
| 6 - Wadi Kabir | 18 - Al Khod |
| 7 - Wattayah | 19 - Seeb Town |
| 8 - Qurum | 20 - Manuma |
| 9 - Qaboos City, Inf. City | 21- Ma 'abela |
| 10 - Qurum Beach | 22 - Qaboos University |
| 11- Al-Khuwair | 23 - Rusail Industrial State |
| 12 - Ghabra, Boashar | 24 - Al Amarat |
| | 25 - Madinat Al Nahda |

**AREAS OUTSIDE MUSCAT AREA ARE:**

| | |
|---|---|
| 26 - Al-Batinah | 30 - Dhofar |
| 27 - Al-Dakhliya | 31 - Musandam |
| 28 - Al -Sharqiya | 32 - United Arab Emirates |
| 29 - Al-Dhahira | 33 - Other countries |

# HOME INTERVIEW

## PART TWO : About Public Transport — Household members opinion

(9) - Please give reason(s) for not using Oman National Transport Company buses as an alternative or mode of travel? ( tick the appropriate box with an X)

1 - Car available and more comfortable .....
2 - The service not familiar to me ...........
3 - Bus service not reliable ....................
4 - Bus-stop too far away .......................
5 - Buses not air conditioned .................
6 - Journey time by bus too long ............
7 - Inadequate service frequency ...........
8 - Poor bus-stop facilities ....................
9 - Bus fares too high .........................
10 - Insufficient luggage capacity ..........
11 - Vehicle provided by employer .........
12 - Other ......................................

(9) - What type of public transport do you think is more available in the following areas ?
( Please tick the appropriate box with an X for each type of public transport)

9.1 - Business and shopping areas

| | A - Easily available | B - Available | C - Not available |
|---|---|---|---|
| 1 - ONTC Buses | | | |
| 2 - Taxis | | | |
| 3 - Pick-up Taxis | | | |

9.2 - Residential areas

| | A - Easily available | B - Available | C - Not available |
|---|---|---|---|
| 1 - ONTC Buses | | | |
| 2 - Taxis | | | |
| 3 - Pick-up Taxis | | | |

9.3 - Along the main roads

| | A - Easily available | B - Available | C - Not available |
|---|---|---|---|
| 1 - ONTC Buses | | | |
| 2 - Taxis | | | |
| 3 - Pick-up Taxis | | | |

(10) - I think public transport is ....... ( Please give your opinion by ticking the appropriate box)

1 - Very good ............
2 - Good ..................
3 - Poor ....................
3 - Very poor ............

## HOME INTERVIEW

**Refer to journey information form**

| | |
|---|---|
| ***TRIP TO BE RECORDED: -** | All trips made during 24 hours of the recorded date only should be recorded. If you have made more than 13 trips please continue on another sheet. |
| ***TRIP DEFINITION:** | Trip is defined as a one-way movement between an origin and a destination for one purpose and by one mode of travel only. A walk to or from a bus-stop or parked vehicle should not be recorded as a separate trip. |
| ***TRIP PURPOSE: -** | The reason for which a trip is made. According to the purpose, person trips are given codes as follows: |
| **1 - Home** | Trips origin and destination. |
| **2 - Work** | Trips to person's place of employment. |
| **3 - Employer's Business** | Travel to carry out the duties of a job for the employer. If self-employed, for the travellers own business purpose. |
| **4 - Personal Business** | Travel in performance of business transaction not part of the duties of employment, e.g. visit to bank, pay bills, personal business, etc. |
| **5 - Education** | This covers all educational purposes, from primary and secondary school through to college and university attendance. A teacher going to school to teach should be coded as "work" |
| **6 - Recreational and Social** | This includes visiting relatives and friends, going to cinema, sports grounds, parks, restaurant, etc. |
| **7 - Shopping** | This means the intention of purchasing and type of personal or household goods including food, clothes, etc. |
| **8 - Hospital** | This includes visit to doctor, dentist, clinic, pharmacy, etc. |
| **9 - Religious** | This includes trips to mosque or other religious reasons. |
| **10 - Other** | All other purposes that do not fit the above descriptions. |

***EACH TRIP YOU MAKE HAS TWO PURPOSES:**

| | |
|---|---|
| **1 - Purpose at origin:** | The purpose of a trip defined by what the traveller does at the origin. For example - leaving home. |
| **2-Purpose at destination:** | The purpose of a trip defined by what the traveller does at the destination. For example - working. |
| ***PARKING DURATION** | The period during which a vehicle remains parked, between end of one trip and beginning of another, excluding parking time at home. |

**Part 3: JOURNEY INFORMATION** | **HOME INTERVIEW** | **For every member of the household over 3 years**

| Please write your | Nationality |
|---|---|
| Age: ........................ | |
| Sex: ........................ | Position |

**Please record below the details of all your trips made on ..............................**

This will normally be one of the working days (Sat - Wed.). After the day you received this form from the interviewer

**Please write area number instead of area name (Place name) as listed below**

| Form No. |
|---|
| *If you made no trips at all on this date write NONE* |
| ........................................ |

Please write below the *AREA NUMBER* of each place you begin and ended your trip

Follow the order that the beginning of one trip is the same as the end of the one before

**When?** Please write below precise *TIME* you begin and ended each trip

**Trip Purpose** | **How did you travel?** | **If you drove a vehicle...** (What sort of parking did you park: off street / on street; Finding a parking space was; Duration of Parking Time Excluding at Home)

| Number of Trips | Where did this trip begin? Trip from | Where did this trip end? to | Left Hr. | Left Mini | Arrived Hr. | Arrived Mini | O- Purpose at origin D- Purpose at destination | Home | Work | Employer's business | Personal Business | Education | Recreation & Social | Shopping | Hospital | Relegious (Mosque) | Others | Walk | Pedal cyclist | Motor cycle | Private vehicle | Taxi | Pick-up taxi | Light commercial vehicle | Heavy commercial vehicle | ONTC Bus | Private bus | Residential | paved private park | paved public park | Vacant land | Paved road side | Unpaved roadside | Not Parked | Easy | Fairly Easy | Difficult | Hr. | Mini | Howmany passengers on board over 5 years |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| please continue on another sheet. | | | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 1 | 2 | 3 | | | |
| *write exact area number and trip time.* | | | | | | | | *Please tick the appropriate box with an "X"* | | | | | | | | | | | | | | | | | | | | *Section above is for vehicle drives only.* | | | | | | | | | | | | |

| Area No & Name | Area No & Name | Area No & Name | Area No & Name | Area No & Name\ |
|---|---|---|---|---|
| 1- Sidab, Bustan, Quntab | 7- Wattayah | 13- Adhuba | 19- Seeb Town | 26- Al- Batina |
| 2- Muscat | 8- Qurum, Mina Al- Fahal | 14- Ghala, Wadi Lansab | 20- Manuma, Al- Shuradi | 27- Al- Dakhliya |
| 3- Muttrah | 9- Madinat Qaboos, Int. City | 15- Airport, Airport Heights | 21- Ma'abela | 28- Al- Sharqiya |
| 4- Darseit, Ruwi North, CBD | 10- Qurum Beach, Diplo. Area | 16- Mawelah | 22- Qaboos University | 29- Al- Dhahira |
| 5- Ruwi South, Hamriya, Wadi Adai | 11- Al- Kuwair | 17- Al- Hail, Al- Khurais | 23- Ryseil Industrial State | 30- Dhofar |
| 6- Wadi Kabir | 12- Ghobra, Bousher | 18- Al- Khod | 24- Al- Amarat | 31- Musandam |
| | | | 25- Madinat Al- Nahda | 32- UAE |
| | | | | 33-Others |

# HOME INTERVIEW

**See the completed form below**

**HOW TO FILL THIS FORM - For Example :**

***Trip One** From Al-Khuwair (Area No. 11) to Qurum (Area No. 8) left at 0715, arrived at 07 30. Purpose at origin home at destination work, private vehicle was used and parked on off-street private car park.
I was driving the vehicle, finding parking space was easy. No passengers were on board in this trip. (This trip was to go to work)

***Trip Two** From Qurum (Area No. 8) to Muscat (Area No. 2), left at 0715, arrived at 07 30. Purpose at origin work at destination employer's business. Government Bus was used.

I was a passenger, so no need to fill a driver section. (This trip was to do a business for may employer in Muscat Town)

*** Trip Three** This trip was to go work after I have done the employer's business

*** Trip Four** This trip was to do a personal business (from the work to the bank).

*** Trip Five** This trip was to go back to work after I have finished the personal business.

*** Trip Six** This trip was to go back home in the afternoon.

*** Trip Seven** Started and ended at the same area Al-Khuwair ( Area No. 11). Purpose at origin home and destination at Mosque ( this trip to go to a Mosque)

*** Trip Eight** This trip was to go back home. Note it was in the same area, i.e. from area number to area number 11.

Please write your Age: 25 Sex: Male | Nationality: Omani | Position: Son

Please record below the details of all your trips made on 6.5.90
This will normally be one of the working days (Sat - Wed.). After the day you received this form from the interviewer
Please write area number instead of area name (Place name) as listed below

Form No. 01 — 01
If you made no trips at all on this date write NONE

Please write below the AREA NUMBER of each place you begin and ended your trip. Follow the order that the beginning of one trip is the same as the end of the one before. | When? Please write below precise TIME you begin and ended each trip | Trip Purpose | How did you travel? | If you drove a vehicle... (What sort of parking did you park: off street / on street; Finding a parking space was; Duration of Parking Time Excluding at Home)

| Number of Trips | Where did this trip begin? Trip from | Where did this trip end? to | Left Hr. | Left Min | Arrived Hr. | Arrived Min | O. Purpose at origin / D. Purpose at destination | Home | Work | Employer's business | Personal Business | Education | Recreation & Social | Shopping | Hospital | Relegious (Mosque) | Others | Walk | Pedal cyclist | Motor cycle | Private vehicle | Taxi | Pick-up taxi | Light commercial vehicle | Heavy commercial vehicle | ONTC Bus | Private bus | Residential | paved private park | paved public park | Vacant land | Paved road side | Unpaved roadside | Not Parked | Easy | Fairly Easy | Difficult | Duration Hr | Duration Min | Howmany passengers on board over 5 years |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11 | 8 | 07 | 15 | 07 | 30 | O | X | | | | | | | | | | | | | X | | | | | | | | X | | | | | | X | | | 05 | 00 | — |
| | | | | | | | D | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | 8 | 2 | 10 | 05 | 11 | 00 | O | | X | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | |
| | | | | | | | D | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 2 | 8 | 11 | 30 | 11 | 45 | O | | | X | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | |
| | | | | | | | D | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 8 | 4 | 12 | 30 | 12 | 40 | O | | X | | | | | | | | | | | | X | | | | | | | | | | | | | | | X | | 00 | 30 | 2 |
| | | | | | | | D | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 4 | 8 | 13 | 10 | 13 | 20 | O | | | | X | | | | | | | | | | X | | | | | | | | | | | | | | X | | | 00 | 40 | 2 |
| | | | | | | | D | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 8 | 11 | 14 | 00 | 14 | 10 | O | | X | | | | | | | | | | | | X | | | | | | | | | | | | | | X | | | | | |
| | | | | | | | D | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 11 | 11 | 15 | 40 | 15 | 45 | O | X | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | 11 | 11 | 16 | 00 | 16 | 05 | O | | | | | | | | | X | | X | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | 11 | 5 | 17 | 30 | 17 | 50 | O | X | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | 5 | 7 | 19 | 00 | 19 | 10 | O | | | | | | | X | | | | | | | | | X | | | | | | | | | | | | | | | | | |
| | | | | | | | D | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | 7 | 11 | 19 | 30 | 19 | 50 | O | | | | | | | | X | | | | | | | X | | | | | | | | | | | | | | | | | | |
| | | | | | | | D | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | 11 | 18 | 21 | 00 | 21 | 20 | O | X | | | | | | | | | | | | | X | | | | | | | X | | | | | | | X | | | 01 | 40 | 4 |
| | | | | | | | D | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | 18 | 11 | 23 | 00 | 23 | 20 | O | | | | | | X | | | | | | | | X | | | | | | | | | | | | | | | | | 00 | 00 | 3 |
| | | | | | | | D | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| please continue on another sheet. | | | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 1 | 2 | 3 | | | |

*write exact area number and trip time.* | *Please tick the appropriate box with an "X"* | *Section above is for vehicle drives only.*

| Area No & Name | Area No & Name | Area No & Name | Area No & Name | Area No & Name\ |
|---|---|---|---|---|
| 1- Sidab, Bustan, Quntab | 7- Wattayah | 13- Adhuba | 19- Seeb Town | 26- Al- Batina |
| 2- Muscat | 8- Qurum, Mina Al- Fahal | 14- Ghala, Wadi Lansab | 20- Manuma | 27- Al- Dakhliya |
| 3- Muttrah | 9- Madinat Qaboos, Int. City | 15- Airport, Airport Heights | 21- Maabela | 28- Al- Sharqiya |
| 4- Darseit, Ruwi North, CBD | 10- Qurum Beach, Diplo. Area | 16- Mawelah | 22- Qaboos University | 29- Al- Dhahira |
| 5- Ruwi South, Hamriya, Wadi Adai | 11- Al- Kuwair | 17- Al- Hail, Al- Khuraiz | 23- Rysell Industrial State | 30- Dhofar |
| 6- Wadi Kabir | 12- Ghobra, Bousher | 18- Al- Khod | 24- Al- Amarat | 31- Musandam |
| | | | 25- Madinat Al- Nahda | 32- UAE |
| | | | | 33-Others |

# APPENDIX "B"

# ROADSIDE INTERVIEW

## *B-01 General*

The purpose of the survey was to collect information about the volume, composition and pattern movements of traffic entering Muscat boundary, known as external trips, thereby, counting vehicles and interviewing a sample of drivers at cordon points in their journey into the study area. The survey was intended to provide detailed information in terms of trip origins and destinations. Therefore, data were collected on the trip purpose, number of stops during the journey, vehicle occupancy, and duration and type of parking at their destination. The information gathered at the interview is shown in *table B1*.

***Table B1***: Information collected in Roadside Interview Survey

| All drivers | Private Vehicles only |
|---|---|
| *Resident Area.<br>*Type of Vehicle<br>* Origin and destination areas.<br>* Times of leaving and arriving.<br>* Origin and destination purposes.<br>*Number of stops by areas and purposes.<br>*Frequency of travel<br>* Type of parking at destination<br>*Availability and duration of parking.<br>* Number of passengers. | * Reasons for not using ONTC buses as mode of travel.<br>* Drivers willingness to use the improved ONTC bus service |

## *B-2 Survey Timetable*

The design of the survey form started on the 4th of August 1990. Pre-survey training of interviewers was held during the three days from 8th to 10th of September. The interviews took place on the 15th and 16th of September, over a period of twelve hour a day in one direction (inbound). The actual hours of interviewing were between 0600 and 1800, representing daylight hours, in 2 working shifts. Each shift included 2 interviewers, one enumerator and two police officers. The researcher was working as supervisor and interviewer simultaneously during the 12-hour period of the survey. Automatic Traffic Counters at the survey stations would help to collect traffic volume in both directions for a minimum of one week, but the lack of access to equipment made it impossible.

*B-3-Development of Forms*

Special care was taken during the design of the questionnaire to avoid bias and ambiguity together with a strict site organisation for the interview and handling of the recorded data. The questions were framed in Arabic and English in such way to ensure the compatibility of the data, and to be precise and require short answers with the minimum amount of writing (*Figure B1*).

Ensuring that the interviewing was time reduced to minimum, the interviewers were provided with clearly defined traffic zones covering all possible trips origins and destinations areas. During interviewing the interviewers were able to memorise the coding for these areas by writing the numeric codes. To improve the quality of the data, the interviewers were introduced in detail to the aspects of the survey accompanied by a pilot survey. The pilot survey not only helped the interviewers to become familiar with the questionnaires, but also enabled sample rate to be estimated and problems to be identified and corrected prior to the survey commencing.

*B-4- Location of Survey Stations*

Muscat Area is linked to the rest of the Sultanate via Al Batinah Dual Carriageway to the West and Nizwa Single Carriageway to the Southwest. The Al Hajar Single Carriageway links a small populated area of Wilayat Quriyat. The interview stations were set up on the Al Batinah and Nizwa Carriageways exactly on the study area boundaries. The stations were selected with a view to minimising delay and danger to road users. The sites were carefully laid out so that drivers could move quickly to their interviewer and safely out into the main stream by using warning sings and rubber cones (*Plate B1 and B2*).

### *B-5- Sampling Method*

Variable sampling method was adopted for roadside interview survey. In this method of random sampling developed by the Road Research Laboratory, interviewers are employed at a constant rate. A total of 424 interviews was produced from Al Batinah station and 388 from Nizwa station, representing 9.2 per cent of total traffic flow on Al Batinah Road, and 14.5 per cent on Nizwa Road.

The Department of Transport in their Advice Note TA/11/81, advise that the first step in selecting a sample is to define the level of accuracy needed or the acceptable error. The number of interviews required can then be obtained. Two levels of required sample were calculated for each station, based on 12-hour traffic flow, according to the Department of Transport Traffic Appraisal Manual 1984, a low sample rate for an accuracy band of 10 per cent and a high sample rate for an accuracy band of 5 per cent. The total of interviews and traffic counts, together with the low and high required sample rates are shown in *Table B2*.

*Table B 2*: Interviews, Traffic Flows and sample rates by Station

| Station | Interviews | 12 Hour Flow | Achieved | Required Low | Required High |
|---|---|---|---|---|---|
| Batinah | 424 | 4602 | 9.2% | 5.1% | 17.6% |
| Nizwa | 388 | 2680 | 14.5% | 8.4% | 26.9% |
| total | 812 | 7282 | 11.1% | 6.8% | 30.8% |

Source: Roadside Interview, Fieldwork, Muscat 1990.

The achieved sample rates in both stations were above the low level required sample rate and this was considered to be satisfactory.

### *B-6 - Interview Procedure*

The selection of traffic for interviewing was controlled by a police officer at the entrance to the bay. The selection was random for all types of vehicles excluding motor cycles, public service, emergency, military, tractors and heavy construction vehicles. The first vehicles to arrive at the station were directed by the police officer into the interviewing bay until each interviewer was occupied. All traffic arriving while those interviews were being conducted was directed past the station. As the vehicle approached the interview bay, the interviewer noted the vehicle type and the number of occupants. When stationary, the purpose of the survey was briefly explained to the driver. The interviewer then commenced the interview by asking the driver to answer the stated questions in a friendly manner. Private vehicle drivers were asked to answer all the questions while others only up to question 18.

The driver was not asked to give the exact addresses of his trip origin and destination, but asked to give the area name. This was adopted to avoid the difficulty of trip origin and destination description in the absence of an address system.

### *B-7- Manual Classified Counts*

A classified count of vehicles in a half hour period was carried out in one direction at each station, concurrently with interviewing for 12-hours (0600 -1800). The form used for traffic counts is shown in *figure B2*. The vehicle categories are identical to those used by the interviewers and are described in *table B3*.

*Table B3:* **Vehicles Categories**

| Class | Vehicle Type | Definition |
|---|---|---|
| 1 | Private Vehicles | Includes cars, estate cars, Jeeps, Four wheel drives, and motor invalid categories. |
| 2 | Taxis | Registered taxis. |
| 3 | Passenger Pick-up | These are specially adapted pick-up trucks used for conveying passengers. |
| 4 | Light Commercial Vehicles | This includes all commercial vehicles up to three tons unladen weight with twin rear tyres. |
| 5 | Heavy Commercial Vehicles | This includes all commercial vehicles over three tons unladen weight with two or more axles. |
| 6 | ONTC Buses | All the Oman National Transport Company buses (scheduled and contract). |
| 7 | Non ONTC Buses | Consist of all works buses, include coaches, and minibuses or microbuses. |
| 8 | Motor Cycles | Motor cycles, mopeds and scooters. |

## *FIGURE B 1:* ROADSIDE INTERVIEW 1990

Form No. .......................... Cordon point ...................... Flow Direction ...................

Hour beginning .................. Day & Date ....................... Interviewer name ..................

(1) - Residence Area ..................................................................................................

(2) - Vehicle type
1- Private vehicle ☐ 3- Pick-up ☐ 5- HC Vehicle ☐ 7- Private bus ☐
2- Taxi ☐ 4- LC Vehicle ☐ 6- ONTC bus ☐ 8- Govt. bus ☐

(3) - Passengers on board (over 5 years) ?
1 - Omani ...........................................................................
2 - Non-Omani ......................................................................

(4) - Where did this trip begin? ..................................................................................

(5) - Why were you there ( trip purpose) ? ...............................

(6) - When did this trip begin? ..................................................

(7) - Any previous stops before here ? 1 - Yes ☐ 2 - No ☐

(8) - If yes ......
1 - Where ........................................................
2 - Why ...........................................................

(9) - Where will this trip end ? ...............................................

(10) - Purpose for going there ? ..............................................

(11) - When will this trip end ? ...............................................

**Trip purpose**

1 - Home
2 - Work
3 - Employer's business
4 - Personal business
5 - Education
6 - Recreation & Social
7 - Shopping
8 - Hospital
9 - Serve passenger
10 - Pick-up or deliver goods
11 - Others

(12) - Do you intend/expect to stop before you ?
1- Yes ☐ 2 - No ☐ 3- No idea ☐

(13) - If yes ......
1 - Where ..........................................................................................
2 - Purpose .......................................................................................

(14) - How often do you travel along this road ... 1 - Regularly ☐ 2 - Occasionally ☐

(15) - If regularly, average number of trips per day ..........................................................

(16) - What type of parking do you intend/expect to use at your destination
1 - Residential car park ☐ 3 - Paved public park ☐ 5 - Paved roadside ☐ 7- No idea ☐
2 - Paved private park ☐ 4 - Vacant land ☐ 6 - Unpaved roadside ☐

(17) - Finding this parking space will be .....
1- Easy ☐ 3 - Difficult ☐
2 - Fairly easy ☐ 4 - No idea ☐

(18) - If not at home, how long do you intend to park there? ..............................................

(19) - What is your reason(s) for not using ONTC buses ?
1 - Car available and more comfortable ☐ 7 - Inadequate service frequency ☐
2 - The service not familiar to me ☐ 8 - poor bus-stop facilities ☐
3 - Bus service not reliable ☐ 9 - bus fares too high ☐
4 - Bus-stop too far away ☐ 10 - Insufficient luggage capacity ☐
5 - Buses not air conditioned ☐ 11 - Vehicle provided by employer ☐
6 - Journey time by bus too long ☐ 12 - Others ☐

(20) Would you be prepared to use ONTC buses, if the quality of the are improved 1 - Yes ☐ 2 - No ☐

**_FIGURE B 1:_ROADSIDE INTERVIEW 1990**

AREAS CODES

The Muscat Area has been divided into 25 areas for the survey purpose
FOR EXAMPLE:
Area number one includes Sidab, Bustan and Qantab
Area number two for Muscat town only
- So -

| Code | Area Name | Code | Area Name |
|---|---|---|---|
| 1 | - Sidab, Bustan, Qantab | 14 | - Ghala Industrial State |
| 2 | - Muscat | 15 | - Airport Heights |
| 3 | - Muttrah | 16 | - Mawelah |
| 4 | - Darsait, Ruwi North, CBD | 17 | - Al Hail |
| 5 | - Ruwi S, Hamriya, Wadi Adai | 18 | - Al Khod |
| 6 | - Wadi Kabir | 19 | - Seeb Town |
| 7 | - Wattayah | 20 | - Manuma |
| 8 | - Qurum | 21 | - Ma 'abela |
| 9 | - Qaboos City, Inf. City | 22 | - Qaboos University |
| 10 | - Qurum Beach | 23 | - Rusail Industrial State |
| 11 | - Al-Khuwair | 24 | - Al Amarat |
| 12 | - Ghabra, Boashar | 25 | - Madinat Al Nahda |
| 13 | - Adheiba | | |

Other areas outside the Muscat Area: -

| Code | Area Name |
|---|---|
| 26 | - Al-Batina |
| 27 | - Al-Dakhliya |
| 28 | - Al-Shrqiya |
| 29 | - Al-Dhahira |
| 30 | - Dhofar |
| 31 | - Musandam |
| 32 | - United Arab Emirates |
| 33 | - Other countries |


*PLATE B 2*: AL-BATINA ROAD STATION

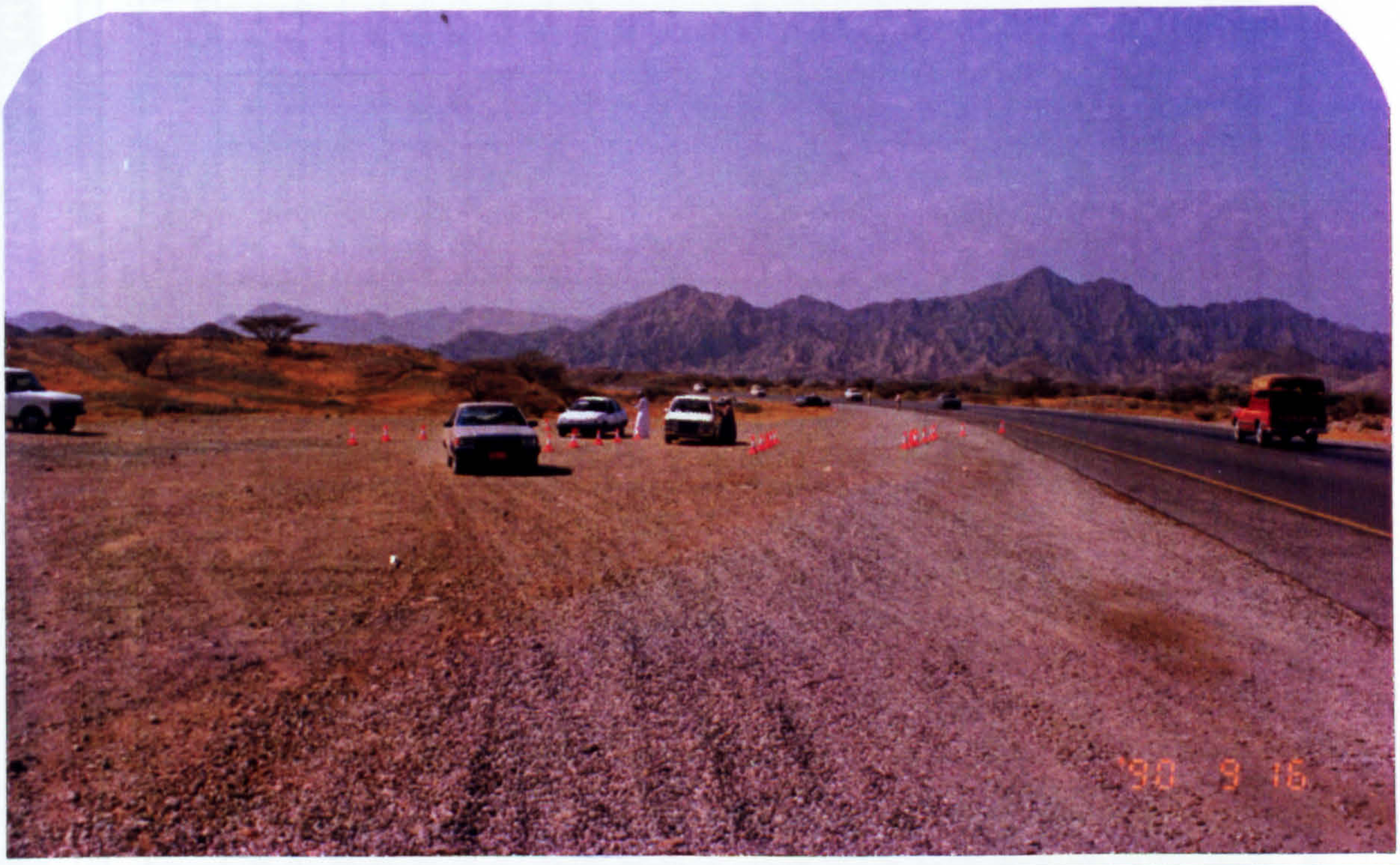


*PLATE B 2*: NIZWA ROAD STATION

**FIGURE B2: CLASSIFIED VEHICLE COUNT FORM (1990)**

Cordon Station. ....................................... Day & Date ..... ............................... Form Number .................................

Flow Direction .................................. Time period beginning ........................... Enumerator ...................................

| Private Vehicle | | | | | | | | | | Taxis | | | Passenger Pick-up | | | | Light Commercial | | | Heavy Commercial | | | ONTC Buses | | | Other Buses | | | Motor Cycle | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 4 | 5 | 6 | 5 | 6 | 7 | 8 | 4 | 5 | 6 | 4 | 5 | 6 | 4 | 5 | 6 | 4 | 5 | 6 | 3 | 4 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 7 | 8 | 9 | 7 | 8 | 9 | 7 | 8 | 9 | 7 | 8 | 9 | 5 | 6 |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 10 | 11 | 12 | 10 | 11 | 12 | 10 | 11 | 12 | 10 | 11 | 12 | 7 | 8 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 13 | 14 | 15 | 17 | 18 | 19 | 20 | 13 | 14 | 15 | 13 | 14 | 15 | 13 | 14 | 15 | 13 | 14 | 15 | 9 | 10 |
| 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 16 | 17 | 18 | 21 | 22 | 23 | 24 | 16 | 17 | 18 | 16 | 17 | 18 | 16 | 17 | 18 | 16 | 17 | 18 | 11 | 12 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 19 | 20 | 21 | 25 | 26 | 27 | 28 | 19 | 20 | 21 | 19 | 20 | 21 | 19 | 20 | 21 | 19 | 20 | 21 | 13 | 14 |
| 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 22 | 23 | 24 | 29 | 30 | 31 | 32 | 22 | 23 | 24 | 22 | 23 | 24 | 22 | 23 | 24 | 22 | 23 | 24 | 15 | 16 |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 25 | 26 | 27 | 33 | 34 | 35 | 36 | 25 | 26 | 27 | 25 | 26 | 27 | 25 | 26 | 27 | 25 | 26 | 27 | 17 | 18 |
| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 28 | 29 | 30 | 37 | 38 | 39 | 40 | 28 | 29 | 30 | 28 | 29 | 30 | 28 | 29 | 30 | 28 | 29 | 30 | 19 | 20 |
| 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 31 | 32 | 33 | 41 | 42 | 43 | 44 | 31 | 32 | 33 | 31 | 32 | 33 | 31 | 32 | 33 | 31 | 32 | 33 | 21 | 22 |
| 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 34 | 35 | 36 | 45 | 46 | 47 | 48 | 34 | 35 | 36 | 34 | 35 | 36 | 34 | 35 | 36 | 34 | 35 | 36 | 23 | 24 |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 37 | 38 | 39 | 49 | 50 | 51 | 52 | 37 | 38 | 39 | 37 | 38 | 39 | 37 | 38 | 39 | 37 | 38 | 39 | 25 | 26 |
| 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 40 | 41 | 42 | 53 | 54 | 55 | 56 | 40 | 41 | 42 | 40 | 41 | 42 | 40 | 41 | 42 | 40 | 41 | 42 | 27 | 28 |
| 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 43 | 44 | 45 | 57 | 58 | 59 | 60 | 43 | 44 | 45 | 43 | 44 | 45 | 43 | 44 | 45 | 43 | 44 | 45 | 29 | 30 |
| 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 46 | 47 | 48 | 61 | 62 | 63 | 64 | 46 | 47 | 48 | 46 | 47 | 48 | 46 | 47 | 48 | 46 | 47 | 48 | 31 | 32 |
| 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 49 | 50 | 51 | 65 | 66 | 67 | 68 | 49 | 50 | 51 | 49 | 50 | 51 | 49 | 50 | 51 | 49 | 50 | 51 | 33 | 34 |
| 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 52 | 53 | 54 | 69 | 70 | 71 | 72 | 52 | 53 | 54 | 52 | 53 | 54 | 52 | 53 | 54 | 52 | 53 | 54 | 35 | 36 |
| 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 55 | 56 | 57 | 73 | 74 | 75 | 76 | 55 | 56 | 57 | 55 | 56 | 57 | 55 | 56 | 57 | 55 | 56 | 57 | 37 | 38 |
| 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 58 | 59 | 60 | 77 | 78 | 79 | 80 | 58 | 59 | 60 | 58 | 59 | 60 | 58 | 59 | 60 | 58 | 59 | 60 | 39 | 40 |
| 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 61 | 62 | 63 | 81 | 82 | 83 | 84 | 61 | 62 | 63 | 61 | 62 | 63 | 61 | 62 | 63 | 61 | 62 | 63 | 41 | 42 |
| 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 64 | 65 | 66 | 85 | 86 | 87 | 88 | 64 | 65 | 66 | 64 | 65 | 66 | 64 | 65 | 66 | 64 | 65 | 66 | 43 | 44 |
| 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 67 | 68 | 69 | 89 | 90 | 91 | 92 | 67 | 68 | 69 | 67 | 68 | 69 | 67 | 68 | 69 | 67 | 68 | 69 | 45 | 46 |
| 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 70 | 71 | 72 | 93 | 94 | 95 | 96 | 70 | 71 | 72 | 70 | 71 | 72 | 70 | 71 | 72 | 70 | 71 | 72 | 47 | 48 |
| 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 73 | 74 | 75 | 97 | 98 | 99 | 100 | 73 | 74 | 75 | 73 | 74 | 75 | 73 | 74 | 75 | 73 | 74 | 75 | 49 | 50 |
| **Total** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# APPENDIX "C"
# PARKING SURVEYS

Parking surveys were carried out in Ruwi High Street, Muttrah Corniche and Central Business Area, where parking is a serious problem. The purpose of these surveys was to obtain the information necessary for assessment of the parking problem in these areas. Three types of surveys were carried out:

1 - *PARKING DURATION:*

The purpose of this survey was to determine the lengths of time that vehicles are parked and their turnover within the survey area. Two methods were used:

i - *Patrol survey*

This method was for on-street parking. The approach involved an observer walking around a section of 20 parking spaces at 15 minute intervals recording the parked vehicles registration numbers and their location. This method of survey was carried out in two locations in Muttrah and Ruwi shopping areas and designed to obtain information on total number of parked vehicles, parking duration and accumulation, arrival and departure rate, and type of vehicles parked. The survey was undertaken on June 24th, 1990 in both locations and continued from 7.00 a.m. to 10.45 p.m. in normal working day.

ii - *Registration Number Survey*

This was an off-street parking survey undertaken on June 23rd, 1990 in one location in Ruwi shopping area including 26 parking spaces. Two observers recorded vehicles entering and leaving the car park by 15 minute from 7.00 a.m. to 10.45 p.m. The data collected were similar to those of the patrol survey.

2 - *PARKING ACCUMULATION SURVEY* ( concentration )

The purpose of this survey was to provide an estimate of total parking spaces available, total vehicles parked and methods of parking. There was a lack of parking inventory and parking control, therefore, an aerial survey was conducted in which photographs were extensively taken on June 27th, 1990 between 11.00 and 12.00 a.m. in specific zones in those areas by using a helicopter provided by the Royal Oman Police.

Most of the difficulties associated with this method were: (1) the invisibility of vehicles due to tall buildings, deep shades and covered parking lots, and (2) the difficulty of relating the photographs to a specific type of parking to locate the number of parked vehicles, their methods of parking and parking spaces available.

3 - *QUESTIONNAIRE*

A reply-paid Questionnaire was administrated in Ruwi and Muttrah shopping areas of the areas that were surveyed by the aerial survey. It was designed to provide a clear picture of the parking difficulty and traffic congestion in the selected areas. A total of 2400 questionnaires were distributed in these locations(*table C1*), 783 were returned, 32 per cent of the distributed. After examining them, the number of valid completed answers was 613. The invalid replies were either answered or incomplete.

*Table C1*: Sample Distributed

| Location | Data | Time | Total distributed | Returned |
|---|---|---|---|---|
| Muttrah | 25-6-1990 | Morning | 500 | |
| | 25-6-1990 | Evening | 600 | 260 |
| Ruwi | 26-6-1990 | Evening | 400 | |
| | 27-6-1990 | Morning | 600 | |
| | 27-6-1990 | Evening | 300 | 353 |
| TOTAL DISTRIBUTED | | | 2400 | 613 |

Data were collected about trip origins, destinations, purposes and mode of travel. In addition, data on vehicle occupancy, duration, type of parking and walking distance to destination, as well as personal opinions and the attitudes towards the problem were obtained. The questionnaire was given in English and Arabic with its purpose and instructions on how to answer the questions (*Figure C1*). As for the distribution of the questionnaires, the questionnaire together with a stamped and addressed envelope were inserted under the windscreen wipers on the parked vehicles, as seen in *plate C1*. Information on vehicle and parking type, area code and method of parking were recorded on-the-spot.

*PLATE C 1*: DISTRIBUTION OF THE QUESTIONNAIRE

*FIGURE C1*: THE REPLY-PAID QUESTIONNAIRE

Stamp Provided

**PARKING SURVEY**

*To be filled by drivers only*

Card No. ................

We carrying out this survey in order to make suggestions where necessary to meet your needs for parking facilities

We would appreciate your help in completing this form (regarding parking space). For most questions this means marking the relevant box with an (x)

*Please post this form at your earliest convenience to ...*

**ROYAL OMAN POLICE**
**Directorate General of Traffic**
**P.O. Box 1100 - Seeb**

*Stamped envelop is provided*

Data ........................ Time ......................

Area .............. Vehicle type ................... Parking type .............. Parking method .............

(1) - Please write name of area where you live ..............................................................................

(2) - Where did your trip start before parking here ? 1 - Area name .......................................
2 - Reason why you were there .....................

(3) - Access to this area was ..... ( Please tick the appropriate box)

1 - Easy ☐ 3 - Difficult ☐
2 - Fairly easy ☐ 4 - Very difficult ☐

(4) If not easy, is it due to ... ( Please tick the appropriate box or boxs)

1 - Heavy traffic ☐ 3 - Poor junction controls ☐ 5 - Pedestrian movement ☐
2 - Narrow roads ☐ 4 - Poor road access control ☐ 6 - On-street parked vehicles movements ☐
7 - Others specify ....................................................

(5) - How many passengers ( over 5 years old) are on board your vehicle ? .........................

(6) - What time did you park here ? ................. a.m. or .................... p.m.

(7) - Finding this parking space was . . 1 -Easy ☐ 2 - Fairly easy ☐ 3 - Difficult ☐

(8) If not easy, did you .......

1 - Cruise around for this space ☐
2 - Wait a long time for this space ☐
3 - Others, please specify ........................................................

(9) - How far is this parking space from your destination ? is it ...

1 - Less than 250 m ☐ 3 - Less than 1 km ☐
2 - Less than 500 m ☐ 4 - More than 1 km ☐

(10) What did you while your vehicle parked here ? at or for .. (Trip purpose)

1- Home ☐ 3 - Business ☐ 5 - Shopping ☐
2 - Work place ☐ 4 - Recreation & social ☐ 6 - Others specify .................

(11) If shopping, please indicate your reason(s) for shopping in this area?

1 - Proximity to home ☐ 4 - Good not obtainable in one shopping area ☐
2 - Variety of goods ☐ 3 - Low prices ☐ 5 - Other ( please specify).............

(12) - What time did you move your car from this parking space ? ........ a.m. or ......... p.m.

(13) - Where did you go after parking? 1 - Area name ........................................................
2 - Reason why you were there .......................................

(14) - Would you be prepared to pay some money(100 Bzs.) for provision of an easy accessible parking space ? 1 - Yes ☐ 2 - No ☐

## OFF-STREET PARKING SURVEY FORM

Form No. ............... Location ................... Parking Type .................

Date ..................... Enumerator ...................... No. of Spaces ..................

1 - Private Vehicle 2 - Taxi 3 - Passenger Pick-up 4 - L.C. Vehicle 5 - H. C. Vehicle 6 - Bus

| Time Starting .................... | | | Time Starting .................... | | | Time Starting .................... | | |
|---|---|---|---|---|---|---|---|---|
| No. | Registration No. | Veh. type | No. | Registration No. | Veh. type | No. | Registration No. | Veh. type |
| | | | | | | | | |

## PARKING SURVEY : PATROL SURVEY FORM (1990)

Form No. ..........................................  Location ..........................................  Parking Type ..........................................

Date ..........................................  Enumerator ..........................................  No. of Spaces ..........................................

Vehicle Type : (1) Private vehicle (2) Taxi (3) Passenger Pick-up (4) Light Commercial Vehicles (5) Heavy Commercial Vehicles (6) Bus

| Space > | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Illegally | Double | In | Out | Acc | Vac |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.00 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7.15 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7.30 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7.45 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8.00 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8.15 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8.30 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8.45 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9.00 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9.15 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9.30 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9.45 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10.00 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10.15 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10.30 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10.45 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11.00 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11.15 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11.30 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11.45 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12.00 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12.15 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12.30 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12.45 | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 13.30 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13.45 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14.00 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14.15 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14.30 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14.45 | | | | | | | | | | | | | | | | | | | | | | | | | | |

Note In = No. of vehicles entered the parking Out = No. of vehicles left the parking Acc = accumulation Vac = Vacant spaces

## PARKING SURVEY : PATROL SURVEY FORM (1990)

Form No. ..........................................  Location ..........................................  Parking Type ..........................................

Date ..........................................  Enumerator ..........................................  No. of Spaces ..........................................

Vehicle Type : (1) Private vehicle (2) Taxi (3) Passenger Pick-up (4) Light Commercial Vehicles (5) Heavy Commercial Vehicles (6) Bus

| space> | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Illegally | Double | In | Out | Acc | Vac |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.00 | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 15.45 | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 22.45 | | | | | | | | | | | | | | | | | | | | | | | | | | |

Note In = No. of vehicles entered the parking  Out = No. of vehicles left the parking  Acc = accumulation  Vac = Vacant spaces

# APPENDIX "D"
# BUS PASSENGER INTERVIEW

The Bus Passenger Interview was intended to gather information about the passengers travel habits and their attitudes towards bus services, which may be important to improve such services. The Survey included: (1) the characteristics and attitudes of the passengers, their trip origin and destination purposes and the regularity of their trips, and (2) information on the mode and time of travel to and from the bus-stop, and waiting time at the bus-stop, in addition to counting the number of passengers boarding and alighting.

The Survey was undertaken on July 14th, 1990 through July 24th, 1990 excluding weekends. The month of July was chosen for the survey because, according to the ONTC, it represents the time when the number of bus passengers is average. The percentage of passengers interviewed are shown in *table 1D*, representing full working day per each route, in 2 working shifts. Each shift included 2 interviewers and one enumerator. The researcher was working as supervisor and interviewer simultaneously during the whole day of the survey in each route.

*Table 1D:* The Percentage of Passengers Interviewed

| Code | Route Name | Date | Total Passengers per route | Total Passengers surveyed buses | Interviewed | Percent route |
|---|---|---|---|---|---|---|
| 31/32 | Muttrah -Al-Amarat | 14-7-90 | 1,306 | 259 | 73 | 6% |
| 28 | Muttrah - Al -Khod | 15-7-90 | 371 | 147 | 57 | 15% |
| 27 | Mabila Local | 16-7-90 | 189 | 189 | 61 | 32% |
| 25 | Ruwi - Adhuba | 17-7-90 | 711 | 260 | 85 | 12% |
| 23/24 | Muttrah - Seeb | 18-7-90 | 979 | 243 | 98 | 10% |
| 08 | Ruwi - Muttrah | 21-7-90 | 467 | 280 | 122 | 26% |
| 04 | Muttrah - Khoula H | 22-7-90 | 591 | 205 | 90 | 15% |
| 03 | Muttrah - Wadi Adi | 23-7-90 | 500 | 317 | 150 | 30% |
| 01 | Ruwi - Wadi Kabir | 24-7-90 | 825 | 302 | 148 | 18% |
| **Total Passengers** | | | 5,939 | 2202 | 884 | 15% |

The questionnaire was designed in such a way as to collect information compatible with the traffic surveys carried out in this study. The questions were given in Arabic and English in such way to ensure the compatibility of the data, and to be precise and require a short answers with the minimum amount of writing.

The questionnaire was given to be answered in writing to passengers who could write in Arabic or English. The passengers who could not write in those languages were asked orally by the interviewer in the passenger's language where possible.

The sampling method was planned in such a way to select every fifth passenger boarding the bus, but during a pilot survey this procedure proved to have some problems such as language problems or the passenger's unwillingness to answer. So the questionnaires were given to all passengers who could write. As mentioned above, the passengers who could not write in Arabic or English were interviewed orally, while the passengers who had difficulty in communication or were unwilling to take were ignored ( *Plate D1*).


*PLATE D1*: INTERVIEWING METHOD

## *FIGURE D 1:* BUS PASSENGER SURVEY

| | |
|---|---|
| Form Number ........................................ | Route Number ........................................ |

| | | |
|---|---|---|
| Time ............................ | Day ................................ | Date ............................ |

Dear passenger

As part of a transport study, we are carrying out this bus passenger survey to learn more about your travel habits and your attitude to bus services, in order to assist in planning improvements in the bus services where necessary to meet your needs in the Muscat Area.

We would appreciate it if you would answer the questions as accurately as possible. For most questions this means marking the relevant box with an "X". If you need help, please ask the surveyor.

Please write area code instead of area name (place name) as listed over-leaf.

### PART 1 About yourself and your attitude to the bus services

1 - Please indicate the number of area where you live ? ............................................................ See over-leaf

2 - Are you ...... a - Omani ☐ b - Non-Omani ☐

3 - Are you ...... a - Male ☐ b - Female ☐

4 - Are you aged ... ... a - Under 18 years ☐ b - 18 to 39 years ☐ c - 40 to 65 years ☐ d - Over 65 years ☐

5 - Area you normally ... ... a - Student ☐ b - Government employed ☐ c - Privately employed ☐ d - Self employed ☐ e - Unemployed ☐

6 - Do you travel on ONTC buses ... ....
a - Regularly ☐ b - Occasionally ☐

7 - If regularly, please write approximate number of trips you made per wee k ..................................................

8 - If Occasionally, when did you last use ONTC buses within the Muscat Area .......
a - This week ☐ b - Last week ☐ c - Long time age ☐

9 - Before starting your journey, do you usually plan to use .......
a - ONTC bus ☐ b - Taxi ☐ c - Pick-up ☐ d - Whichever comes first ☐

10 - Is there someone else in your house who owns a car or has use of a car ?
a - Yes ☐ b - No ☐

If yes, please indicate number of cars in your house ...................................................................

# BUS PASSENGER SURVEY

## PART 1 About yourself and your attitude to the bus service

11 - Do you own a car ? a - Yes ☐ b - No ☐

12 - If you own a car, what is/are your reason(s) for using this bus ?

a - Own car is being used by someone else. ☐
b - Own car is under repair. ☐
c - Own car is not available in the Muscat Area. ☐
d - Bus is cheaper. ☐
e - Bus is more convenient. ☐
f - Bus travel is safe ☐

13 - Do you consider that the bus route you use most often is generally ..........

a - Reliable ☐ c - Unreliable ☐
b - Moderately reliable ☐

14 -Would you be prepared to pay more for more better quality of service ?

a - Yes ☐ b - No ☐

15 -Please tick the appropriate box with an [X] for your opinion on the following aspects of ONTC services.

| | a - Satisfactory | b - Not satisfactory |
|---|---|---|
| 1) - Convenience of the bus-stop to your home | ☐ | ☐ |
| 2) - Availability of bus shelters | ☐ | ☐ |
| 3) - Travel information | ☐ | ☐ |
| 4) - Service frequency | ☐ | ☐ |
| 5) - Bus runs on time | ☐ | ☐ |
| 6) - Drivers attitude to passengers | ☐ | ☐ |
| 7) - Fare rate | ☐ | ☐ |
| 8) - Luggage capacity | ☐ | ☐ |
| 9) - Air-conditioning facilities | ☐ | ☐ |
| 10) - Bus cleanliness | ☐ | ☐ |
| 11) - Overall seat comfort | ☐ | ☐ |
| 12) - Convenience of journey time | ☐ | ☐ |
| 13) - Convenience of changing buses | ☐ | ☐ |
| 14) - Convenience of the bus-stop to your most usual destination | ☐ ☐ | ☐ ☐ |

## BUS PASSENGER SURVEY

### PART 2 Origin Information

16 - Please indicate the area number instead of the area (place name).

a - Where did you start your journey ? ..............................................................

b - Where did you take this bus ? .......................................................................

17 - Why were you there ?

- a - Home ☐
- b - Work place ☐
- c - Employer's business ☐
- d - Personal business ☐
- e - Education ☐
- f - Recreation & social ☐
- g - Shopping ☐
- h - Medical ☐
- i - Religious ☐
- j - Others ..... specify ................ ....................................................

18 - How did you get to this bus-stop ?

- a - Walk ☐
- b - Private vehicle ☐
- c - Commercial vehicle ☐
- d - Taxi ☐
- e - Pick-up ☐
- f - ONTC bus ☐
- g - Non-ONTC bus ☐
- j - Others ..... specify .................. ....................................................

19 - If you walked to the bus-stop, how many minutes did it take ?

- a - Under 5 minutes ☐
- b - 5 to 10 minutes ☐
- c - 10 to 15 minutes ☐
- d - 15 to 20 minutes ☐
- e - 20 to 30 minutes ☐
- f - Over 30 minutes ☐

20 - What is the approximate distance between you trip origin and the nearest bus-stop ?

- a - Under 250 m ☐
- b - 250 to 500 m ☐
- c - 500 to 1000 m ☐
- d - 1 to 2 km ☐
- e - 2 to 3 km ☐
- f - Over 3 km ☐

21 - For how long did you wait at the bus-stop for this bus ?

- a - Under 5 minutes ☐
- b - 5 to 10 minutes ☐
- c - 10 to 15 minutes ☐
- d - 15 to 20 minutes ☐
- e - 20 to 30 minutes ☐
- f - Over 30 minutes ☐

## BUS PASSENGER SURVEY

### PART 3 — Destination Information

22 - Please indicate the area number instead of the area (place name).

a - Where will you leave this bus ? ..........................................

b - Where will your journey end ? ..........................................

23 - Why are you going there ?

- a - Home ☐
- b - Work place ☐
- c - Employer's business ☐
- d - Personal business ☐
- e - Education ☐
- f - Recreation & social ☐
- g - Shopping ☐
- h - Medical ☐
- i - Religious ☐
- j - Others ..... specify ..................

24 - How will you continue to your destination after leaving this bus ?

- a - Walk ☐
- b - Private vehicle ☐
- c - Commercial vehicle ☐
- d - Taxi ☐
- e - Pick-up ☐
- f - ONTC bus ☐
- g - Non-ONTC bus ☐
- j - Others ..... specify ..................

25 - If you have to walk to your destination, how long will it take ?

- a - Under 5 minutes ☐
- b - 5 to 10 minutes ☐
- c - 10 to 15 minutes ☐
- d - 15 to 20 minutes ☐
- e - 20 to 30 minutes ☐
- f - Over 30 minutes ☐

26 - What is the approximate distance to your destination after leaving this bus ?

- a - Under 250 m ☐
- b - 250 to 500 m ☐
- c - 500 to 1000 m ☐
- d - 1 to 2 km ☐
- e - 2 to 3 km ☐
- f - Over 3 km ☐

## BUS PASSENGER INTERVIEW 1990

### AREAS CODES

The Muscat Area has been divided into 25 areas for the survey purpose
FOR EXAMPLE:
Area number one includes Sidab, Bustan and Qantab
Area number two for Muscat town only
- So -

| Code | Area Name | Code | Area Name |
|---|---|---|---|
| 1 | - Sidab, Bustan, Qantab | 14 | - Ghala Industrial State |
| 2 | - Muscat | 15 | - Airport Heights |
| 3 | - Muttrah | 16 | - Mawelah |
| 4 | - Darsait, Ruwi North, CBD | 17 | - Al Hail |
| 5 | - Ruwi S, Hamriya, Wadi Adai | 18 | - Al Khod |
| 6 | - Wadi Kabir | 19 | - Seeb Town |
| 7 | - Wattayah | 20 | - Manuma |
| 8 | - Qurum | 21 | - Ma 'abela |
| 9 | - Qaboos City, Inf. City | 22 | - Qaboos University |
| 10 | - Qurum Beach | 23 | - Rusail Industrial State |
| 11 | - Al-Khuwair | 24 | - Al Amarat |
| 12 | - Ghabra, Boashar | 25 | - Madinat Al Nahda |
| 13 | - Adheiba | | |

Other areas outside the Muscat Area: -

| Code | Area Name |
|---|---|
| 26 | - Al-Batina |
| 27 | - Al-Dakhliya |
| 28 | - Al-Shrqiya |
| 29 | - Al-Dhahira |
| 30 | - Dhofar |
| 31 | - Musandam |
| 32 | - United Arab Emirates |
| 33 | - Other countries |

## BUS PASSENGER COUNT FORM

| | | |
|---|---|---|
| Form Number ...................... | Fleet Number ........................ | Day ..................................... |
| Route Number .................... | Enumerator ........................... | Date ..................................... |

| Trip No. | Direction | Bus stop No. | Time | | Passengers Boarding | | | | Left behind | Passengers Leaving | | | | Total on Board |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Omani | | Non-Omani | | | Omani | | Non-Omani | | |
| | | | Hrs | Min | M | F | M | F | | M | F | M | F | |
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